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A Traveling Stage for Marine Construction.

In the construction of marine structures subjected to the occasional or constant battering of a heavy sea, or in the blasting of sub-aqueous rock where the same rough conditions prevail, there is always great difficulty in providing stable supporting stages upon which the men may work and the construction machinery and material may be carried. In the case of piers or breakwaters extending out into rough water, construction is always started from the comparatively sheltered shore and the completed portion used as a base from which to extend the line of work further seaward, but even with this solid footing on which to operate, the breaking waves are very apt to make the safety of the working end of the structure most doubtful, unless expensive, high and easily removable travelers are used. In the case of drilling and blasting, a heavy sea must cause a shut down of all floating drill-boats or rock chisels. Within the past few years there has been developed in England a traveling stage, known, after its inventor, as the Piercy Locomotive Stage, to be used for just this sort of work, and in at least four separate pieces of work has proved most successful. At first glance this stage appears to be of too sensational a type to be of real value and its very general exploiting in the popular press as the "machine that walks to its work" has not advanced its standing in the engineering profession. It has, however, admirably served its purpose where used, and deserves the attention of all engineers engaged in harbor engineering.

Fundamentally, the device consists of a large stage resting normally on four columns or spuds, and provided with an upper platform on which all erecting machinery and material may be carried. Its special feature is that it has two sets of supporting columns, each set forming a unit which may be raised and moved ahead while the structure is resting on the other set. In this way, by alternately raising and moving the spuds, the stage can be moved to any place desired, regardless of the height or the condition of the sea, and at the same time, when once fixed, has a very solid footing with a working platform high above the water. Its appearance is well shown in Figs. 1 and 4.

Fig. 2 gives the details of one of the stages which has been used. This shows only the outline framing with none of the working machinery other than that necessary to manipulate the stage proper. In plan it consists of three separate rectangular frames of structural steel, labeled in the drawing A, B, and C. Frame A is supported at its four corners on columns, frame B rests on the side girders of frame A, and frame C rests on the transverse girders of frame B, at the same time being provided with four corner supporting columns. Where each frame rests on the one below, the support is formed by an upper and lower wheel, so that the lower may be supported from the upper and the upper rest on the lower, as is desired. At the same time these wheels act, as rollers, so that the free frame may be run along the bearing girder while being supported by the stable frame. Each of the columns is a structural member carrying inside of it a timber spud which may be raised or lowered from a worm gear on the main platform.

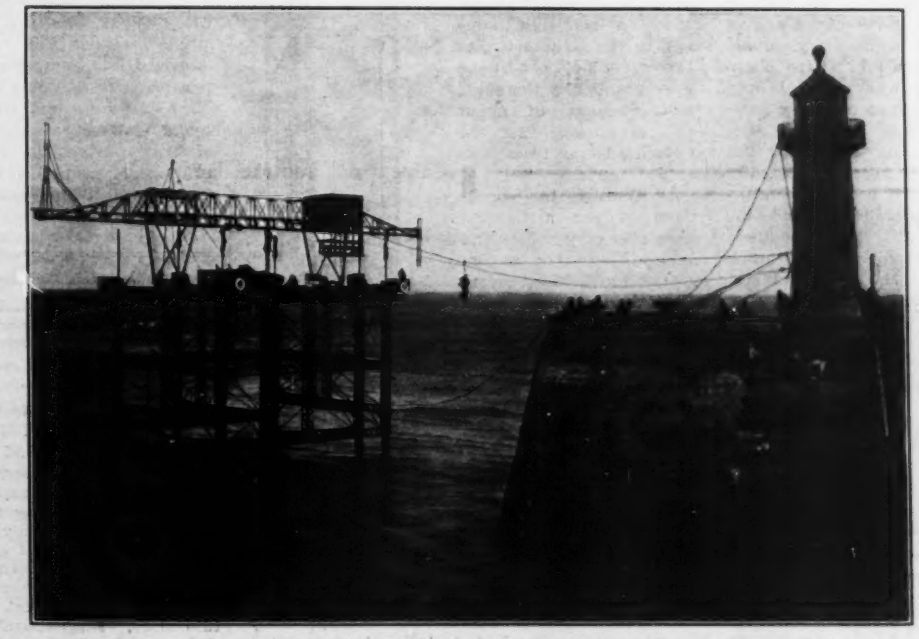


FIG. 1. THE "PIERCY" TRAVELING STAGE AT WORK AT WHITBY HARBOR, ENGLAND.

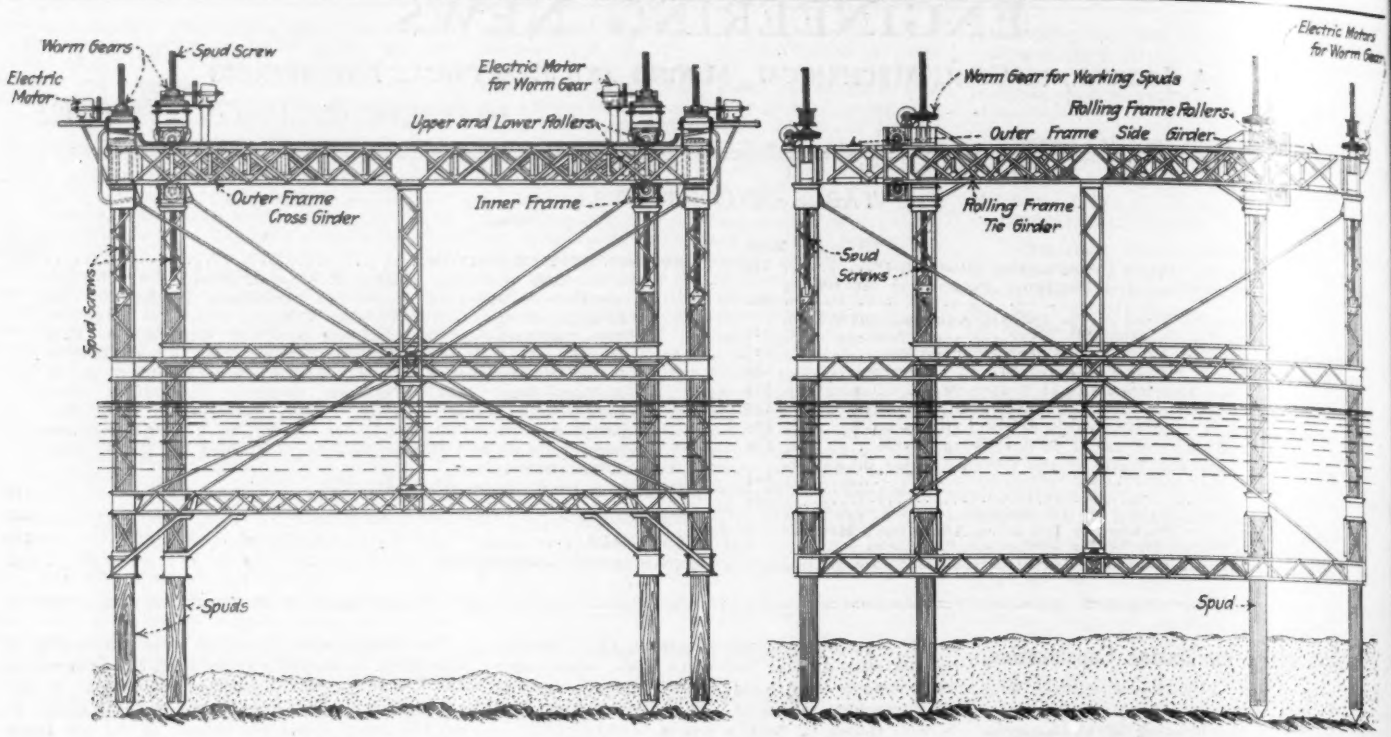
The procedure of operation is shown in Fig. 3. The seven views there given trace the progress of one complete step forward of the stage. In (a) are eight spuds all drawn firm in the bottom; in (b) the inner spuds are raised; in (c) the inner frame is moved forward; in (d) the inner spuds are lowered; in (e) the outer spuds are raised; in (f) the outer spuds are moved forward, and in (g) all spuds are drawn again on a firm base, the whole machine being some 5 or 10 ft. ahead of its former position, depending on the leeway in the frames as constructed. In these diagrams the frame B is not shown, nor is it operated for any forward movement. If the stage is to be moved sideways, this is accomplished by moving frame C along frame B, when the inner spuds are raised. Each one of the frames is so designed that it can safely support the whole load of the stage and its accessories. All the movements are controlled by engines mounted on the working platforms.

For ordinary bottoms where a solid footing may be expected a short distance below the bottom, iron shoes pointed at the ends are used on the spuds, but on a sand bottom a spread footing of timbers is used to distribute the load sufficiently. This is attached to the bottom of the spud and raised and lowered with the spud.

To show the general size of the stages the following dimensions of two used in England may be quoted.

	Peterhead.	Whitby.
Outer frame—plan. ft.	23.4 × 34.5	48.5 × 48.5
Outer frame—hgt. ft.	26.1	33
Rolling frame—plan. ft.	23 × 23.8	31.1 × 46.2
Inner frame—plan. ft.	15 × 23	29.5 × 40.2
Inner frame—hgt. ft.	29.4	33
Spuds, ins.	12 × 12	16 × 16
Possible movement forward, ft.	6	10
Possible movement side, ft	6	3
Weight—tons	50	130
Top girder above high water, ft.	—	21

Under ordinary conditions the smaller of these could be moved the whole distance forward and sideways (6 × 6 ft.) in 30 mins., but this stage was not provided with power to operate the



End Elevation. Side Elevation.

FIG. 2. DETAILS OF CONSTRUCTION OF "PIERCY" STAGE.

spuds. On the larger stage which had electric motor control of the spuds, the forward movement of 10 ft. was made in 15 mins. and, with an inexperienced crew, the whole stage could be moved 300 ft. in ten hours.

The stages have been very successfully used in three localities in England; in the drilling and blasting of the harbors of Peterhead and of Dover and in constructing a masonry breakwater at Whitby. At Peterhead, where channel deepening and widening was required in a rock bottom, the site was exposed to heavy gales and to seas running 15 to 25 ft. in height. Ordinary floating drill boats were first tried but could only be used in the occasional calm weather. The conditions were considered altogether too severe for a spud barge and the necessary movements over a large area made any fixed staging too expensive. The stage noted in the above table was then installed and equipped with five heavy compressed-air drills supplied with power through pipes from shore. This proved very satisfactory in the 6 to 20 ft. of water necessary. The holes were drilled from the stage and the blast fired while the stage was still in place, with no resulting damage to the structure. At Dover, the conditions were practically the same and a stage of about the same size as the Peterhead machine was used.

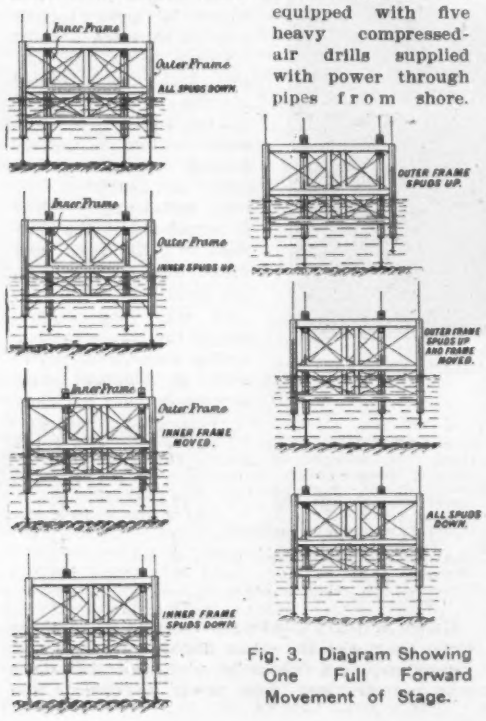
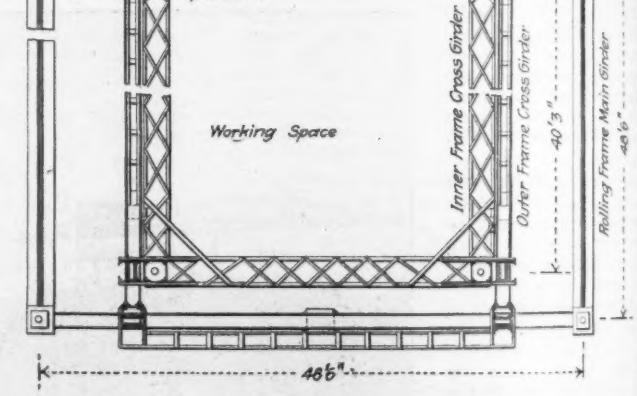


Fig. 3. Diagram Showing One Full Forward Movement of Stage.

At Whitby, the conditions of sea and wind were also very severe, and in addition the bottom was of hard shale, covered by a thin layer of sand, so that there would have been difficulty in making secure a stationary staging. Two breakwaters were to be built, extending out from the shore, and two stages each of the dimensions shown in the above noted table were built. These were erected on the sandy shore at the location where the breakwaters started and were "walked" out ahead of the work as it progressed. One stage traveled about 1,000 ft. and the other about 3,000 ft., following the curved lines of the breakwaters. They were each provided with an overhead traveler, which was used for the concrete laying operations. Exceptionally heavy weather prevailed during a large portion of the work, so heavy in fact that the men were often carried to the stage by overhead traveler, rather than to risk their lives in a boat, but the work was carried to a rapid and successful conclusion. The views in Figs. 1 and 5 are of the Whitby work.

A new stage has recently been built at Cape Town, South Africa, to be used in the construction of the Adderley St. Pier there. This is a reinforced-concrete structure 45 ft. wide, extending 1,400 ft. into the ocean, and is founded on reinforced-concrete piles. The stage is equipped with a pile-driver and it "walks" ahead of the completed pier, driving the piles as it goes.

The locomotive stage is the invention of Mr. R. A. Piercy, an English engineer, and the rights of its manufacture are vested in the British contracting firm of W. Hill & Co., Westminster, London. This firm had charge of all three of the British contracts described herein.



An Aluminum Alloy for Engine Cylinders.—In Engineering News, July 2, 1909, p. 13, and July 9, p. 41, a new alloy of aluminum and magnesium was described as having greater hardness and strength than aluminum, but retaining desirable qualities of that metal. The most recent use of this alloy, "Magnalium," is for internal-combustion engine cylinders. It is reported that many attempts to use aluminum for this service have been made, but always unsuccessfully, since it was not possible to get castings dense enough to hold the pressure and since the metal became very brittle under the repeated explosions. It is claimed that "Magnalium" metal has given sound castings for such work and that such a cylinder, with an iron piston and iron rings, becomes highly polished, while the iron takes the wear where there is cause for scoring. The thermal conductivity is 7 to 8 times that of iron which leads to easier cooling of the cylinder walls. The metal is reported to be some 12½% lighter than the common No. 12 aluminum (93% aluminum and 7% copper) and has a specific gravity of 2.50. Messrs. G. A. Crayen, 81 New St., New York City, are American Agents for the makers, the Magnalium Syndicate, of Berlin, Germany.

Tests of Water Sterilizing and Purifying Methods at Marseilles, France.

The municipality of Marseilles, France, in preparation for the construction of a new water purification plant, about a year ago, instituted an extensive series of tests to determine the relative effectiveness of a number of methods of water purification. Eight different types of apparatus were installed in small units, their operation studied through a number of days (more than a month), and the condition of the effluent thoroughly examined for physical, chemical and bacterial changes. A resume of the results is given by M. Edmond Bonjean, one of the consulting engineers on the work, in the August issue of "La Technique Sanitaire et Municipale," from which we have prepared the following abstract.

As has been the growing tendency among French sanitarians, it seems that every effort is to be made at Marseilles to procure a water absolutely sterile, as well as pleasing to taste and smell and sight. For this reason most of the tests were made on sterilizing apparatus, which, though slower and more expensive than the methods generally used to procure a potable water, under good working conditions, aim to guarantee a water absolutely free of any bacterial life. Each installation was designed to treat 52,840 gals. of water in 24 hrs. As the daily consumption of water at Marseilles amounts to about 36,000,000 gals., it will be seen that every little detail of the installation and operation of the test methods had to be most carefully adjusted and observed in order to make the small tests at all comparable to the intended system for the whole city. An attempt was made to get at relative costs, but so far the results are not available.

FIG. 4. THE STAGE IN SHORE BEFORE MOVING OUT TO SEA.

The eight different installations were as follows: (1) Puech-Chabal roughing filters, followed by filtration through submerged sand beds; (2) and (3) Puech-Chabal roughing filters, followed by sand filters fed by (a) Baudet's distributor and (b) by Brocq's "rotating epicycloidal" distributor; (4) ultra-violet ray apparatus, preceded by Puech-Chabal roughing filters; (5) ozone treatment (Otto system); (6) ozone treatment (Siemens de Frise system); (7) sulphate of aluminum and chloride of lime treatment (Duyk system); and (8) sulphate of aluminum (Desrumaux system).

CONDITION OF UNTREATED WATER.—The raw water at Marseilles is held in a reservoir before entering the city mains, so that it has a settling period which partially removes the suspended matter, but this purification is very incomplete, for the water to be treated by the new plant—in the same condition as that treated by the experimental plants—is opaque at a depth of 20 ins. If submitted to a prolonged settling period, however, it becomes quite clear. Its chemical composition is quite satisfactory, but its bacterial content is very high and dangerous. The source of the water is subject to all sorts of contamination, which varies at different seasons and under different conditions, but is always sufficient to render the water a possible source of disease. Analysis showed a test of from 600 to 2,500 bacteria per c. c., and from 1,000 to 15,000 B. coli per liter in the raw water.

Results of Tests.

SAND FILTERS.—The Puech-Chabal roughing filters,* formed of broken stone grading in size from large to small, were installed in large enough units to pass 158,520 gals. per 24 hrs., one-third of which went subsequently to submerged sand filters, one-sixth to each of the sand filters fed by the special distributors, and one-third to the ultra-violet ray apparatus. The pre-filtering was very effective in clarifying the water and in materially reducing the bacterial content. Unfortunately, a bacterial examination of the water immediately after passing the roughing filters were made only in the case of the ultra-violet ray installation. Here it was found that the bacterial content had been reduced to 22 to 24 bacteria per c. c. As will be noted below, this is a more effective purification than is shown by the water which has passed both roughing and sand filters, so that it is open to doubt.

The submerged sand filters, 5.2 ft. thick and 110 sq. ft. in area, passed 2½ gals. per sq. ft. of surface per hr. (about 2,500,000 gals. per acre per day). While the effluent showed an improvement in the bacterial content, the purification was not considered satisfactory. The raw water content was reduced to about 20 to 48 bacteria per c. c. and a very occasional evidence of B. coli.

The two non-submerged sand filters were not constructed according to the rigorous conditions demanded by the inventors of the special distributors, so the tests upon them cannot be considered conclusive. The two nozzles did not insure the uniform distribution of the water over the sand bed, and the beds themselves were of such poor composition and construction that they soon became clogged. Nevertheless, the bacterial content, during effective operation, was reduced to from 10 to 50 bacteria per c. c., and B. coli were not found.

The results obtained by the use of the ultra-violet ray method have been noted before in Engineering News (Dec. 8, 1910, p. 633). As stated above, the water arriving at the apparatus had from 22 to 24 bacteria per c. c.; the effluent showed from 1 to 3 germs. The engineers in charge of the work felt that the comparability of the small-size test plant and a large installation was not at all assured, and they are still open to conviction as to the efficiency of this method of purification.

OZONE INSTALLATIONS.—The Otto system of ozone treatment was described in Engineering News, April 28, 1910, p. 488. In this type of apparatus the air, ozonized electrically, is passed to an "emulsor," in which the water under treatment draws in the ozonized air and mixes with it. The small plant installed at Marseilles comprises a roughing filter of gravel, a prefilter of sand and the final ozonizing apparatus. Electrical energy was furnished at 25 cycles, 110 volts and stepped up to 250 cycles, 11,500 volts. The data for the tests are as follows:

Wgt. of air per cu. meter of ozonized air (concentration)	2.3 gr.
Vol. of ozonized air per cu. m. of water	306 lit.
Wgt. of ozone per cu. m. of water	0.709 gr.
Quantities of ozone in 1 cu. m. of ozonized air	2.2-2.6 gr.

The water passing the prefilter was clear and chemically satisfactory, with a bacterial content of from 140 to 250 germs per c. c., and with traces of B. coli. The bacterial content of the purified water was from 2 to 5 germs per c. c., with no evidence of B. coli.

The Siemens de Frise system of ozone treatment was described in Engineering News, April 28, 1910, p. 488. As noted there, it comprises a settling basin, a prefilter of sand and the final ozonizing apparatus. The data for this plant are as follows:

Wgt. of air per cu. m. of ozonized air (concentration)	1.88 gr.
Vol. of ozonized air per cu. m. of water	1 082 lit.
Wgt. of ozone per cu. m. of water	2.034 gr.
Quantities of ozone in 1 cu. m. of ozonized air	1.85-2.05 gr.

The prefiltered water showed from 27 to 72 bacteria per c. c., including traces of B. coli. The final effluent had from 3 to 9 germs, with no evidence of coli. In both of these installations the resulting effluent had no traces of unpleasant taste or smell. On account of the satisfactory results obtained from the tests of the ozone treatment, the engineers considered it the most promising of any of the methods tested.

FIG. 5. THE STAGE AT WHITBY IN ROUGH WEATHER.

CHEMICAL TREATMENTS.—The Duyk system comprises, first, the passage of the raw water through a settling basin and then its dosing with a solution of sulphate of aluminum and chloride of lime. The dosing solution is made up of a 4% solution of pure aluminum sulphate, 450 gr. of which is added to each cubic meter of raw water to be purified and a 2% solution of commercial chloride of lime, 100 cu. cm. of which is added to each cubic meter of raw water. This is equivalent to 18 parts of alum and 2 parts of chloride of lime per million. The effluent, while clear, showed no marked improvement in taste and smell over the raw water. The bacterial content was reduced from 133 to 26 bacteria per c. c. after three days.

The Desrumaux system comprises a settling basin and a dosing with sulphate of aluminum, 48 parts per million of raw water. The results were about the same as in the Duyk system, although the bacterial reduction was not great.

*Described in article "Novelties in Filtration and Their Theory," by Ad. Kemna, Engineering News, March 26, 1908, p. 328.

Cement Lining for Steel Pipes on the Catskill Aqueduct, New York City Water Supply.

At the recent meeting of the New England Water Works Association (Sept. 13-15, 1911), Mr. Alfred D. Flinn, M. Am. Soc. C. E., Department Engineer, Board of Water Supply, New York City, read a paper entitled "Protection of Steel Pipes in Catskill Aqueduct," describing the lining of some 33,000 ft. of steel pipe with cement. From that paper we have prepared the following abstract:

In the 92 miles of 500,000,000-gal. aqueduct between Ashokan reservoir and the city line there are numerous valleys to be crossed, varying in width from a few hundred feet to several miles. For 14 of these depressions, steel pipe siphons were determined upon as the most economical and otherwise suitable type of construction. Seven siphons are in the Northern Aqueduct department, north of Croton watershed, and the remaining seven are in the Southern Aqueduct department; they are being constructed under two corresponding contracts: No. 62, with the Snare & Triest Co., and No. 68, with the T. A. Gillespie Co. West of the Hudson River there are three siphons and east of the river, eleven.

To convey water to the full capacity of the other portions of the aqueduct, three pipes will ultimately be required, but since the city does not need the whole capacity for a number of years, only the middle pipe of each siphon is now being laid. Between Ashokan and Kensico reservoirs the pipes are approximately 9 ft. in diameter; from Kensico reservoir to the connection for the proposed filter plant they are 9½ ft. in diameter; and from the latter point to Hill View reservoir, 11 ft., for economical reasons, depending upon the available slope. The middle pipe alone will carry approximately 350,000,000 gals. daily, far more than one-third the capacity of the three pipes all together. At each end of each siphon is a concrete siphon chamber forming the connection with the adjacent cut-and-cover or tunnel portion of the aqueduct. In each chamber sluice gates for controlling the flow of water into the several pipes will be installed. These chambers will have suitable superstructures; the chambers but not their superstructures are included in the contracts mentioned.

Having settled upon metal pipes, the next most important phase of the problem was to make these siphons as nearly as feasible comparable in durability to the masonry types of aqueduct. Attention was directed first to finding a pipe metal less corrodible than steel. Such evidence as was at hand and could be collected within the time at our disposal, pointed rather clearly to genuine wrought iron as being superior in this respect to other metals. Investigation, however, disclosed the facts that wrought iron could not be obtained in sufficiently large sheets and its strength would be less, hence the thicknesses of the pipes would be greater, leading to greater cost. Cost would not have been a controlling factor if satisfactory assurance of accomplishing the desired result had accompanied increased expenditure. Deliveries, furthermore, would probably have been too slow for the necessary progress in construction. Consequently, it was decided to use the best available quality of steel.

Steel having been selected as the metal for the pipe plates, attention was directed to the best method of protecting it. Reports of experience from many places and special examinations of many steel pipe lines of varying ages gave convincing proofs that none of the pipe coatings commonly used was possessed of qualities giving it more than a few years' useful life. One or two cases of use of Portland cement mortar on a small scale in pipes and wide experience in reinforced-concrete construction of the protective action of the cement on the steel pointed to a method for coating the pipes. After some study it was decided to jacket the steel siphons of the aqueduct outside with rich concrete mixed about one part of cement to three parts sand and six parts broken stone or gravel, with a minimum thickness of 6 ins., and to line them with Portland cement mortar, 2 ins. thick at the minimum. Standard cross sections of the 9-ft. 5-in. pipes are shown in Fig. 1. The other sized pipes have the same details.

Methods of applying the concrete and mortar next received consideration. Improvements for attaining intimate, complete and permanent adhesion, in spite of the unavoidable changes in shape and the elastic distortions of the pipes were sought, along with the most economical and practicable methods for the various steps in covering and lining. Preparation of the steel to receive concrete and mortar was also carefully studied. Numerous experiments were conducted especially on placing the lining.

Mortar lining experiments were made at nearly full size. A steel pipe 9 ft. in diameter and 12 ft. long, of ⅝-in. riveted plates, was lined by plastering with metal reinforcement of several styles, by plastering with terra cotta and cement blocks or tiles, and by pouring grout or very thin mortar into the space between a cylindrical steel form and the interior surface of the pipe. To summarize the results briefly, no combination of plasterer's skill with various kinds of Portland cement mortar, reinforced or unreinforced, gave linings that were adequate, and this method was expensive. Bedding tiles of terra cotta or mortar about 1 in. thick and 6 to 8 × 12 ins. in plan on mortar applied directly to the pipe surface, and, after setting, building up the lining to the required thickness with successive coats of mortar troweled on was much more satisfactory but was also expensive. The grouting method proved by far the most satisfactory and least expensive and was made the basis of the specifications. With proper regard for certain details this last method gave promise of being feasible in actual construction. It also had the advantage of producing a monolithic lining which was considered desirable, especially the avoidance of layers in the thickness, since it is well known to be difficult to cause one layer of Portland cement mortar or concrete to adhere absolutely and permanently to another without expensive and troublesome precautions. As the successive experimental linings were removed from the test pipe it was observed quite generally that linings applied in layers separated.

As the result of these studies and experiments the following specifications were written:

Mortar Lining for Steel Pipes.

The lining shall consist of Portland cement and sand, mixed in ordered proportions, probably one part of cement to two parts of sand. The quality of the sand shall be as specified. The lining shall be of substantially uniform thickness throughout the entire circumference except for the unavoidable variations due to lap of the plates, butt straps and rivet heads. The thickness over the inner course of plates is to be 2 ins., that is, the internal diameter of the lining shall be 4 ins. less than the nominal diameter of the steel shell.

Forms shall be of steel, or of wood covered with galvanized sheet steel, and shall be especially constructed so as to have sufficient strength and yet be adjustable so as to give uniform space between them and the shell of the pipe. Great care shall be exercised to secure forms which will leave the surface of the lining perfectly smooth. Forms which give unsatisfactory results after use shall be satisfactorily repaired or replaced. The length of the sections of forms will not be restricted provided satisfactory means are adopted for controlling the uniform thickness of the lining and the correct spacing of the reinforcement; but sufficient sections shall be provided adapted for lining the pipe on curves, where lining shall be placed in sections about 7 ft. long. Each time the forms are used they shall be thoroughly cleaned and then coated with some approved inadhesive substance which will prevent the mortar from sticking to the forms without injuring the mortar. The lining of manhole castings, and of the blow-off elbows to the sockets, shall be monolithic with the lining of the steel shell, and forms shall be so constructed as to permit this method.

The lining shall in general be placed by pouring as grout around an internal form, through holes cut in the top of the pipe for that purpose. Sections shall be so terminated as to bring a hole at the upper end which shall be arranged as an air vent. The mortar shall be mixed to a thick creamy consistency and allowed to flow into place as uniformly as possible. When the section is filled to the top, the pouring of the grout shall be continued until grout runs from the air vent; then headers of steel pipe shall be screwed into the inlet and outlet holes and filled with grout so as to put a head of at least 4 ft. on the highest part of the section, and these headers shall be kept filled with grout until the grout has set, when the pipe shall be removed and the hole made water-tight by a screw plug. During the pouring of the grout, the form shall be tapped to loosen air bubbles and a careful watch shall be maintained to prevent leaks. The work shall be so planned that the grout can be poured continuously from start to finish of the section. Any interruption greater than 15 mins., whether due to leaks or any other cause, may be sufficient reason for the rejection of the entire section.

Should there be any portion of the interior of the pipe which it is impracticable to line by grouting, this portion shall be lined by plastering the pipe with mortar. Only skilled masons or plasterers shall be allowed to do this plastering, and a section once started shall be prosecuted until finished, with only such pauses as are necessary for a sufficient setting of a layer to permit the next layer to be placed. Each layer shall be as thick as is feasible to apply so that as few layers as possible may be necessary. The surface of each layer, except the final one, shall be brushed to thoroughly remove the laitance and then deeply scratched or otherwise satisfactorily treated to give a bond with the succeeding layer.

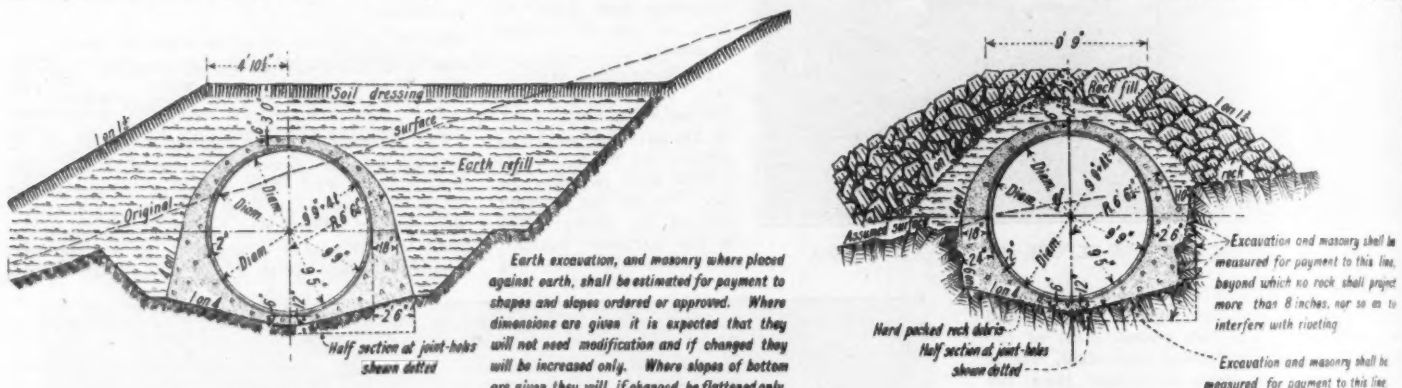
The forms shall be removed within 12 hours of the time set by the Engineer and the section, if accepted, shall receive immediately such repairs as required, in the manner directed. It is possible that the lower part of the lining will, in many cases, show a sandy surface, and if so, it shall be brushed with enough neat cement wash to fill the pores and no more, and troweled to a smooth finish. Any section not accepted shall be immediately removed by the contractor at his own expense and replaced by acceptable lining.

Suitable bulkheads shall be erected in the pipe to prevent freezing inside the pipe either during the placing of the lining or after its completion. They shall be removed before the completion of the contract, if ordered.

Reinforcement of Mortar Lining for Steel Pipes.

Reinforcement may be ordered for any part or the whole of the mortar lining. The reinforcing material shall be galvanized steel mesh of a style and weight approved, provided, however, that no reinforcement shall be required of which the lowest price obtainable by the contractor, f. o. b. New York City, exceeds ¾ ct. per sq. ft., for lots of 10,000 sq. ft.

The reinforcement shall be placed approximately in the center of the mortar lining. The reinforcement may be kept away from the pipe by distorting the reinforcement at frequent intervals, so as to make points projecting toward the pipe. Unless otherwise permitted, small blocks of mortar shall be attached to the reinforcement, for the purpose of keeping it away from the form. Metal shall be lapped at least 6 ins. at all longitudinal joints.


4'10½"
Soil dressing
surface
Earth refill
Original
Diam
9'-4½"
R 6'-6"
9'-5"
18"
2'-6"
Half section at joint-holes shown dotted
Earth excavation, and masonry where placed against earth, shall be estimated for payment to shapes and slopes ordered or approved. Where dimensions are given it is expected that they will not need modification and if changed they will be increased only. Where slopes of bottom are given they will, if changed, be flattened only.
9'-9"
Rock fill
Assumed surface of rock
Hard packed rock debris
Half section at joint-holes shown dotted
Excavation and masonry shall be measured for payment to this line, beyond which no rock shall project more than 8 inches, nor so as to interfere with riveting
Excavation and masonry shall be measured for payment to this line beyond which no rock shall project.

IN DRY LOOSE EARTH. IN ROCK.

FIG. 1. TYPICAL SECTIONS OF CEMENT-LINED AND CONCRETE COVERED STEEL PIPE SIPHONS, CATSKILL AQUEDUCT.

Fig. 1 shows typical sections of a 9-ft. 6-in. pipe where laid in dry loose earth and in rock; similar sections with slightly differing details were provided for rock and loose earth, compact earth, rock and compact earth, partly on rock, on embankment and in sheeted trench. All of the pipes were being laid by the cut-and-cover method, proceeding as follows: The cut to the proper shape and elevation is first made and along it are placed at intervals a series of cradles, upon which the steel pipe is laid and riveted up.

After the laying and riveting in the ditch have been completed the pipe is filled with water to hydraulic gradient, inspected, and leaks calked. For this purpose—unless the siphon chamber has been built in time—bulkheads have been placed in the open ends of the pipe and a small riser pipe carried up to the proper elevation, and water kept just spilling over the top of this small pipe or of a tank at its top. While still full of water under normal working pressure, the steel pipe is jacketed with concrete; this pressure is continued until the last concrete placed has attained considerable strength, a period depending upon weather, kind of cement, and other conditions. The pipe

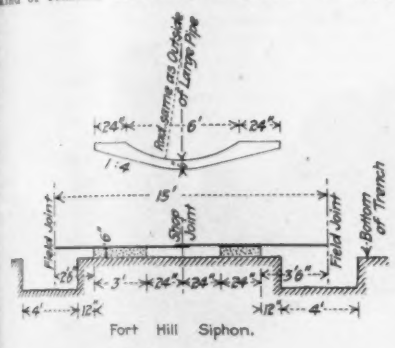


Fig. 2. Typical Cradles for Supporting Steel Pipe Prior to Concreting Catskill Aqueduct Siphons.

is then emptied and preparations made for lining. The methods for placing the concrete jacket have not differed essentially from those usual for concrete conduit construction.

The cradles used along the work varied in shape and size according to the conditions and the contractor, but in general they consisted of a series of concrete blocks cast in place, one under each ring, and so curved on the upper surface as to provide a fit for the circular pipe which was laid upon them. Fig. 2 shows the details of a typical cradle and Fig. 3 a view of a series of them in place preparatory to placing the pipe. In soft ground considerable difficulty was experienced in keeping the cradles true to line and grade and in providing an upper curve which would support the pipe for the full arc. While in general they have proved satisfactory, there have been a great number of breakages due partly to unsatisfactory bearing of the pipe during the long periods that it was supported entirely on the cradles and partly to careless handling of the pipe.

Methods of Lining Pipes.

For lining the pipes, two distinctly different methods have been adopted by the two contractors: on Contract 62 grouting with forms has been employed, and on Contract 68 mortar has been applied by means of the "cement gun."

INSIDE FORMS.—Practical difficulties militated against the use of a complete cylindrical form; such as getting around curves, vertical or horizontal; collapsing one section of form sufficiently to pass forward through another which must remain in place while the grout is hardening; cleaning, lubricating and inspecting outside of form. Consequently, the invert for a width of about 8 ft. of arc is placed first by methods similar to those of concrete sidewalk construction.

Under Contract 62 metal-covered wooden forms in panels about 2 ft. wide and 15 ft. long, adjusted on centers and firmly braced, are used for pouring the remainder of the lining in 15-ft. sections at one operation. The grout is poured from outside the pipe through a 2½-in. wrought-iron pipe secured into a rivet passing hole at the down-hill end of the section. This pouring pipe is long enough to give a head of about 4 ft. on top of the up-hill end of the section. A vent pipe is screwed in the up-hill rivet passing hole of the section, the bulkhead forming the end of the lining being placed just below it. At the finish of the pouring a small pipe is inserted through the large vent pipe and extended through the bulkhead, to permit the escape of the last air while grout is poured through the larger pipe, and churned into the small remaining space to insure complete filling. The first batch or two of grout is mixed 1 part cement to 1 part sand, and the remainder about 1 to 2 (Fig. 4).

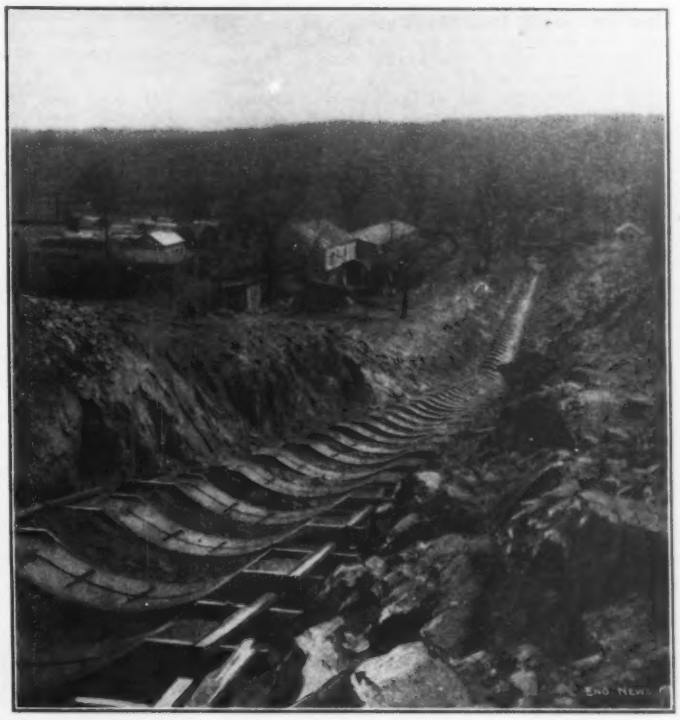


FIG. 3. VIEW OF SECTION SHOWING CRADLES IN PLACE.

On portions of Contract 68 the so-called "cement-gun" was used to make the interior lining. Many feet of pipe were lined in this manner, but the method has since been discontinued, at the instance of the contractor, because of its high cost. The "cement-gun" is a recently perfected device, whereby a dry mixture of sand and cement is forced by compressed air through a nozzle and is mixed just before its exit, with sufficient water to form a grout, which can be played upon a surface from the nozzle of the hose. The whole machine, compressor, and air, water, cement and sand mixture tanks are mounted on one carriage which may be moved from place to place. Fig. 5 shows two of the machines on the siphon arch pumping the grout through hose to the interior lining.

With this machine the process of lining is to place the invert as in the grout method and then build up the arch for the remainder of the circumference in layers placed in rapid succession. Each layer has a rough surface, to which the next adheres well; the first layer on the steel is about ½-in. thick, and others follow at short intervals, a section 15 ft. long being completed in a few hours. It is impossible to secure a satisfactory smooth finish with the "cement gun," and so the final layer is floated and trowled before it hardens. By both grouting and the gun methods very smooth interior surfaces are being secured.

In using the cement gun, charges of dry sand and cement mixed in prescribed proportions are placed in the chamber of the machine and then rapidly discharged by air under 50 to 60 lbs. pressure through a rubber hose; through a parallel hose, joining the first in a special nozzle, water under pressure is discharged so that the sprays of water and of sand and cement are combined. The nozzle pressure is about 30 lbs. and so the material is thrown with considerable force against the surface to which it is being applied. This aids in securing the excellent union between the layers. The operative holds the nozzle about 2 or 3 ft. from the surface being coated, moving it back and forth continuously. The flow from the nozzle is controlled by means of lever valves.

One result of the high pressure at the nozzle is that a measurable proportion of the sand bounds off the surface upon which the mixture impinges and falls into the bottom of the pipe, especially when beginning the first layer on the bare steel. This dry material, practically all sand, with some cement, is clean and is collected for use in making the invert. In view of this action, an excess of sand is put into the dry mixture, in order that the lining may be no richer than intended. Another incidental result is that the atmosphere inside the pipe is commonly very dusty, and in order to provide reasonable working conditions for the men, artificial ventilation is resorted to.

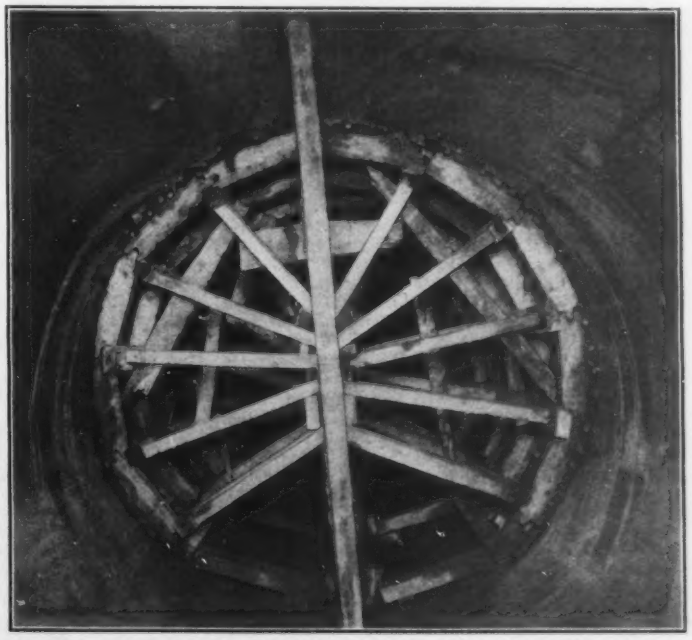


FIG. 4. VIEW OF CONSTRUCTION OF CEMENT LINE SIPHONS USING INSIDE FORMS.

A third result is that the mortar is less well supplied with water than in the grout, and more attention must be given to keeping the lining moist in order to minimize shrinkage cracks. Failure fully to appreciate the necessity for this moistening in the initial use of the gun was probably contributory to the formation of rather numerous fine cracks. Inevitable temperature changes due to the setting of the cement enhance the tendency to crack. In spite of this untoward circumstance, a highly satisfactory lining was secured. As an aid to preventing cracks and a safeguard against the remote possibility of small pieces of the lining becoming loose and falling, provision was made in both contracts for inserting wire fabric in the mortar; up to date, none has been used.

Absolute adhesion of concrete or mortar to the steel is not being secured at all points, as has been proved by careful sounding with a hammer, but on cutting into hollow sounding spots the space between the mortar or concrete and the steel has been found almost infinitesimal in width. What effect will such failure to adhere have upon the protective action of the lining? No better reply can be made at present than a brief statement of some experiments at the Board's laboratory.

Tests on Adhesion of Concrete to Pipe.

One test was arranged as follows: Six steel plates, 8 x 16-in., No. 12 gage, cleaned by pickling and then by rubbing with emery cloth, were placed horizontally in a galvanized iron tank 18 ins. in diameter and 24 ins. deep, separated from the bottom by two 1¼-in. bars of alberene stone, and from each other by ½-in. wood dowels. The first pair of plates were put in without any protective covering. The second pair had their upper surfaces protected by a slab of cement mortar 2½ ins. thick, not in contact with the steel, but separated from it by two metal strips about 0.04-in. thick. The third pair of plates was protected by cement mortar slabs 2 ins. thick, cast directly on the steel, and apparently adhering to it firmly. The tank was then filled with Croton water to a depth of 4 ins. above the top of the uppermost mortar slab, and kept filled the entire duration of the test, the water being renewed twice monthly.

After two years' exposure, the plates were taken out and cleaned off by washing with a sponge. The first pair of plates showed heavy corrosion. In numerous places the entire layer of oxide had separated from the steel and formed blisters, leaving the bright steel surface underneath. The second pair of plates showed a very slight corrosion. Most of this washed off, thus indicating a considerable protective influence of the mortar slabs even when separated from the metal by a space of 0.04-in. When the mortar slabs were removed from the third pair of plates, it was found that a part of the surface of the steel had a distinctly different appearance from the other part. One part was clean and wet; the other part was covered by strongly adhering particles of mortar and was dry, thus indicating that there had been actual adhesion of the mortar only over the latter part of the surface and that the former had been separated by a space large enough for the water to enter. There had, however, been no rusting except at some places near the edges of the wet part of the surface, where apparently the space had been big enough to allow circulation of the water. The water in the rest of the space had evidently been so highly charged with lime that no corrosion could take place.

Another test was arranged as follows: Four circular slabs 15¼ ins. diameter and 3 ins. thick were made of concrete in proportions 1 cement : 2.7 Jerome Park screenings : 6.3 Jerome Park stone by weight, the consistency of the mix being rather dry. Carefully embedded in the center of the slabs were four ¾-in. round soft steel rods spaced 3 ins. apart, so that there was at least 1½ ins. of concrete in all directions from the rods. When the concrete had set, two of these slabs were immersed in water in two tanks 1 ft. 6 ins. in diameter and 2 ft. deep. The other two slabs had two galvanized iron cylinders 15¼ ins. in diameter cemented to them, and a head of 20 ins. of water maintained on them. The water in the tanks and cylinders was kept at a constant depth and head by the addition of water whenever it was necessary to do so. The slabs subjected to percolation leaked rapidly at first, but became gradually tighter, and during the last few months of the tests there was very little leakage. The tests were conducted in open air, and were subject to the variations in outdoor temperature. The tests commenced July 13, 1907. On March

TABLE I.—CONTRACT PRICES FOR STEEL PIPES, CONCRETE JACKET AND MORTAR LINING. CATSKILL AQUEDUCT.

Description.	Contract price.		Average of all bids. (5 bidders)	
Contract 62				
9-ft. 6-in. steel pipe, 7/16-in. plate, lap jointed	$31.00	lin. ft.	$35.56	lin. ft.
9-ft. 6-in. steel pipe, ½-in. plate, lap jointed	35.00	" "	41.20	" "
9-ft. 6-in. steel pipe, ½-in. plate, longitudinal seams butt-jointed	40.00	" "	44.80	" "
9-ft. 6-in. steel pipe, 9/16-in. plate, longitudinal seams butt-jointed	43.00	" "	48.80	" "
9-ft. 6-in. steel pipe, 11/16-in. plate, longitudinal seams butt-jointed	47.00	" "	55.80	" "
9-ft. 6-in. steel pipe, ¾-in. plate, longitudinal seams butt-jointed.	50.00	" "	56.60	" "
Mortar lining for steel pipes	2.50	" "	4.90	" "
Reinforcement of mortar lining for steel pipes	.02	sq. ft.	.03	sq. ft.
Concrete masonry around steel pipes	6.00	cu. yd.	5.85	cu. yd.
Portland cement	1.75	bbl.	1.74	bbl.
Contract 68.			(8 bidders)	
9-ft. 9-in. steel pipe, 7/16-in. plate, lap jointed	27.00	lin. ft.	33.25	lin. ft.
11-ft. 3-in. steel pipe, 7/16-in. plate, lap jointed	33.00	" "	37.37½	" "
11-ft. 3-in. steel pipe, ½-in. plate, lap jointed	40.00	" "	42.75	" "
11-ft. 3-in. steel pipe, ½-in. plate, longitudinal seams butt-jointed	43.00	" "	48.75	" "
11-ft. 3-in. steel pipe, 9/16-in. plate, longitudinal seams butt-jointed	50.00	" "	53.62½	" "
Mortar lining for 9-ft. 9-in. steel pipe	4.00	" "	3.56¼	" "
Mortar lining for 11-ft. 3-in. steel pipe	4.50	" "	4.04½	" "
Reinforcement of mortar lining for steel pipe	.03	sq. ft.	.02¾	sq. ft.
Concrete masonry around steel pipe	4.50	cu. yd.	5.78	cu. yd.
Portland cement	1.50	bbl.	1.72½	bbl.

FIG. 5. CEMENT-GUNS AT WORK LINING STEEL PIPE WITH CEMENT GROUT.

TABLE II.—DIMENSIONS OF CATSKILL AQUEDUCT PIPE SIPHONS.

Name of siphon.	Length, feet.	Thickness of plate, in ins., and kind of joints	Maximum head, feet.	Diameter of pipe shell, ft. ins.	Finished diameter of siphon, ft. ins.
NORTHERN AQUEDUCT DEPARTMENT.					
West of Hudson River.					
Esopus	2,110	7/16, lap	107	9 6	9 2
Tongore	643	7/16, lap	72	9 6	
	53	9/16, long seams butt-jointed		9 6	
Total	696				
Washington Sq.	3,281	7/16, lap	90	9 6	
East of Hudson River.					
Foundry Brk.	3,490	7/16, lap	192	9 6	
	288	1/2, lap			
Total	3,778				
Indian Brk.	608	7/16, lap	70		
Sprout Brk.	1,061	7/16, lap	234	9 6	
	119	1/2, lap			
	1,044	1/2, long seams butt-jointed.			
Total	2,224				
Peekskill	2,162	7/16, lap	340	9 6	
	218	1/2, lap			
	1,251	1/2, long seams butt-jointed.			
	1,876	9/16, long seams butt-jointed.			
	1,025	11/16, long seams butt-jointed.			
	139	3/4, long seams butt-jointed.			
Total	6,671				
SOUTHERN AQUEDUCT DEPARTMENT.					
Hunter's Brk.	1,493	7/16, lap	110	9 9	9 5
Turkey Mt.	1,510	7/16, lap	92	9 9	9 5
Harlem R. R.	694	7/16, lap	60	9 9	
Kensico	1,625	7/16, lap	50	9 9	10 11
Elmsford	1,490	7/16, lap	68	11 3	
Fort Hill	1,267	7/16, lap	72	11 3	
Bryn Mawr	2,714	7/16, lap	214	11 3	
	150	1/2, lap		11 3	
	2,465	1/2, long seams butt-jointed		11 3	
	255	9/16, long seams butt-jointed		11 3	
Total	5,584				
Total length of all siphons	33,031				

1909, the slabs were broken and rods examined for corrosion. It was found that the protection of the rods by the concrete was perfect in all cases, there being no sign of corrosion on either the black finish of the metal left by the rolls, or on the bright ends of the rods exposed in cutting to length with the hacksaw. The concrete when broken was found to be thoroughly saturated, showing that the water had full access to the rods.

Manufacture of Steel Pipe.

All pipes for both contracts were fabricated by the East Jersey Pipe Co., Paterson, N. J., from plates rolled at the Carnegie steel mills near Pittsburgh. After the plates had been beveled, planed on their edges and punched for the rivets, each was bent to proper radius by rolls. This latter operation cracked the mill scale and loosened it pretty thoroughly, incidentally removing a considerable portion; to remove the remaining mill scale, the rust and dirt, the plates were then dipped vertically in a wooden tank containing hot dilute sulphuric acid. This pickling solution was kept at a strength of about 5% of oil of vitriol, which was about 93% of pure sulphuric acid. This bath was maintained at a temperature of about 125° F., and each plate was in it about 15 mins. When removed, the plates were of a uniform, clear steel gray all over, and were at once dipped in clean hot water in an adjacent tank, to remove all acid. Fitting and riveting followed promptly. The pipes were made in 15-ft. sections, each of 2 rings of 7½-ft. net length. Each ring was of one plate, excepting in the 11-ft. 9-in. pipes, and in pipes made of plates thicker than ½-in., for which two plates were necessary.

As a partial protection against rusting between fabrication and the application of the concrete and mortar, each pipe was given a coat of heavy lime whitewash, made as follows:

To one barrel of whitewash (about 50 gals.) there were added 20 lbs. of glue; after using this whitewash for a time, about one pound of Portland cement was added for each gallon of whitewash; the glue was dissolved in water before being mixed in the whitewash.

This whitewash was applied with brushes. A spraying machine operated by compressed air was tried but found unsatisfactory. The whitewash did not adhere very well, and through lack of care in handling the pipes suffered more or less almost as soon as applied. The pipes did not suffer from cracking off but from exposure to the weather, and even where the whitewash was not disturbed, rusting occurred. The only place where there was no sign of rusting was around the rivets and at joints, where the whitewash had formed a very thick coating. Consequently, the pipes arrived at the trench with more or less complete coats of light yellow rust; this rust was very uniform on the bared portions of the steel surface, without indications of any tendency to pitting and has been regarded as unobjectionable. Unfortunately, however, delays in laying some of the pipes and further delays in covering them with concrete permitted the gradual formation of heavier rust, which had to be removed, as required by the specifications. Any remaining whitewash is removed before applying the concrete or mortar. Ease of removal and absence of serious effects upon the concrete or mortar if small quantities should not be removed were among the principal reasons for adopting lime whitewash. Portland cement grout would have adhered more tenaciously, but difficulty of ultimate removal and its probable interference with the good adhesion of the final concrete and mortar coatings to the steel were sufficient arguments for forbidding its use. There is room for improvement in this step of our process for protecting steel pipes.

Costs of Work.

The cost to the city of the pipes and their protection is indicated by the contract prices for the important items given in Table I on page 528. It is too early to compute accurately the cost to the contractors. So large a proportion of the jacketing and lining remains to be done that there is room for improvement in methods or gain in facility of operation with present methods, both of which may affect contractor's costs. Parts of the narrative of this type of construction cannot be written for a few years.

In all 23,031 lin. ft. of pipe was called for by the contract, in the detailed sizes shown in Table II.

Summary.

To sum up, the intended constructional results are being substantially attained. Consequently, with information so far collected, it is reasonable to anticipate a close approximation of the desired measure of protection for the steel pipes. One of the greatest obstacles to ideal results, from the point of view of protection of the steel, is the difficulty of getting the pipes jacketed with concrete and covered with earth soon after delivery. The steel mill and fabricating shop naturally push their operations to completion much more rapidly than the pipe can be laid, tested and covered.

It is hoped that these pipes will last a hundred years; they may last much longer, barring accidents. Some abuse or unappreciated condition may lead to earlier partial failure, necessitating reconstruction. The gain in smoothness of interior by covering the rivet heads and the plate laps has been computed to so increase the hydraulic capacity that three pipes equal four without lining. The total cost for the siphons with three lined and jacketed pipes is estimated as about the same as for four pipes constructed and coated in the more usual way. Obvious incidental advantages are secured by the more permanent construction.

Engineering operations of the Catskill waterworks are being directed by J. Waldo Smith, chief engineer, and Merritt H. Smith, deputy chief engineer; Robert Ridgway and Frank E. Winsor are department engineers, respectively, of the Northern and the Southern aqueduct departments. In immediate charge of the construction of the siphons are Division Engineers John P. Hogan, Alexander Thomson, Jr., and George P. Wood; George G. Honness, Ernest W. Clarke and Charles E. Wells. The drawings and specifications were prepared and many of the preliminary investigations conducted by Senior Designing Engineer Thomas H. Wiggin, and Engineer Inspector Ernst F. Jonson has had charge of inspection at the rolling mills and pipe shops, all under the immediate supervision of the writer.

A British Revival of an Abandoned American Invention.

"There is nothing new under the sun," remarked Solomon. We are reminded of that sage maxim by the report which we find in our English exchanges concerning a paper read at the recent meeting of the British Association for the Advancement of Science, entitled "A New System of Continuous Transportation for Passenger and Other Services."

The following summary and discussion of the paper is given in London "Engineering":

The proposal of the author, Mr. W. Y. Lewis, was to lay a screw with a variable pitch between the tracks, supported on rollers. This screw was continuous from end to end of the track, and was driven at intervals by motors. Separate and independent vehicles were used, which engaged with the screw by two rollers. At the stations the pitch of the screw was reduced, so as to bring down the speed of the car to three miles an hour, at which it could be easily boarded. In this deceleration 80% of the kinetic energy stored in the car was restored to the system. No brakes and no signals were required. The cars could not collide, being always a definite number of "pitches" apart. With this system he claimed that effective speeds could be increased 25%, and operating costs diminished to one-fourth, and the initial to one-half of what was required with existing methods. It was possible to adapt the system to curves.

Trials made with a plant erected at Messrs. Ransome's works, Ipswich, showed efficiencies ranging from 88 to 95%, varying with the pitch of the thread. At the high-speed section of the track the load on the screw would be 20 lbs., which during periods of acceleration would rise to a maximum of 600 lbs. A length of screw could, he added, be taken out and replaced in two hours.

A letter from Captain Sankey was read by the Secretary. It stated that he had tested the plant at Ipswich, and had been surprised at the smallness of the power required, and at the large return of energy during periods of deceleration. There was no difficulty in getting on and off the cars, and accelerations as high as 4.5 ft. per second were realized.

Professor Dalby said that it was interesting to note that the system was entirely a mechanical one, and that it did not exist merely on paper, but could be seen in operation at Ipswich, the plant there being the result of seven years' development work.

In calling on the author to reply, Mr. Charles Hawksley, who occupied the chair in the absence of Professor Biles, said that the device would have a wide future if it attained the success the author anticipated.

In reply, Mr. Lewis said that he had to treat the matter somewhat scantily, his paper having only been prepared the previous Saturday. He claimed that his system would give better results than the existing subways, both in facilities and in initial and operating costs. The screw, he said, was 2 ft. in diameter, and weighed about 100 lbs. per foot. It would not matter if it cost a pound per foot run. With it he could, without a jerk, graduate the acceleration from zero up to its maximum value.

Twenty-two years ago the problem of street-car propulsion was a live one. Horse cars were still in general use, the cable system was at the height of its popularity and the electric motor was just beginning to make its superiority felt. Inventors were at work on all sorts of schemes for street-car propulsion, promising and unpromising.

Among these inventors was one by the name of Judson who worked out the details of a system, substantially identical with that described in the above extract from "Engineering" as being actually experimented with in England at the present day. Readers who are interested may turn to Engineering News of July 13, 1899 (p. 28) and find a full description of the Judson system. Mechanically the scheme was an extremely ingenious one. Instead of an actual screw, Mr. Judson placed a line of steel tubing in a conduit beneath the street surface and kept this tubing rotating at high speed by motors attached at intervals. The cars engaged this rotating cylinder by two wheels on opposite sides which could have their angle altered so as to trace a spiral on the tube surface in either direction and so drive the car either backward or forward and at variable speed.

Of course a competent mechanical engineer even at that day could perceive the hopelessness of any such complicated and expensive system ever reaching commercial success; but in this day of successful electric traction it is little short of amazing that the proposition could be revived and actually attract capital enough to construct an exhibition system.

Twenty-three Constitutional Amendments to the State Constitution of California were adopted at a special election on Oct. 10. Some of these are of interest as relating to engineering questions. By one amendment, the Railroad Commission is increased from three to five members who are to be appointed by the Governor, instead of being elected as heretofore. The term of service is extended from four to six years, but members of the Commission may be removed for cause by two-thirds vote of the Legislature. All powers vested in boards of supervisors or other governing bodies of the counties, cities and towns, or in any commission already existing, cease so far as their powers conflict with those conferred on the State Railroad Commission. Every private corporation and every individual or association owning or operating any commercial railway, interurban, or street railway, canal, pipe line, or any railroad equipment for the transportation of passengers or freight, or for the transmission of messages or for the production, transmission and furnishing of heat, light, water or power, is defined as a public utility subject to the control and regulation of the Railroad Commission. The Commission has the power to supervise and regulate all such utilities and to fix the rates for commodities furnished or services rendered. The right of the Legislature to confer power on the Railroad Commission respecting utilities is declared plenary and unlimited by the Constitution.

Another amendment gives the right to any municipal corporation to establish and operate public works for supplying independents with light, water, power, heat, transportation and communication services. Such works may be constructed or purchased. A municipal corporation may furnish service to independents outside its boundary line, but it may not compete with any municipality without the consent of the other municipality.

Fixed-End Columns in Practice.

By C. T. MORRIS, Mem. Am. Soc. C. E.*

Many specifications and most handbooks give column formulas for two or three different sets of end conditions. These are usually (1) two pin ends, (2) one pin and one fixed end, and (3) two fixed ends. The question which the designer must decide is which of these formulas should be used in a given case. The fixed-end formula will permit the use of a lighter column; hence the question is, What constitutes a fixed end and how can it be secured?

The usual relation between these formulas is such that the strength of a pin-end column of a given length is the same as that of a flat-end or fixed-end column of double the length. This relationship is in accordance with the theory of the ideal "long column."

The conditions in practice are seldom (if ever) such that either end of a column is absolutely fixed, or is absolutely free to turn.

The condition shown at "a" in Fig. 1 may be met in the case of a post carrying a load on top, without lateral support and firmly built into masonry at the bottom. For the ideal hinged-end column, "b" in Fig. 1, the nearest approach in practice is the column with pin bearings. The friction on the pin must be overcome before the column can deflect as shown, and this friction partially fixes the end of the column. The condition of fixed ends shown in "a," "c" and "d" is seldom if ever met with in practice. The only way that this condition could be approached would be by building the ends of the column into masonry, and then the effective length L would have to be taken as commencing at some little distance below the surface of the masonry on account of the partial elasticity of the material. A riveted end or a flat bearing does not nearly approach the condition of fixed end, on account of the elasticity of the end connection.

In each case in Fig. 1 the length "l" represents the distance from a point of contraflexure or zero bending moment to a point of maximum bending moment; L represents the total length between ends.

The elastic lines of some practical columns which are frequently considered as fixed-ended or flat-ended can be drawn, showing approximately the location of the points of contraflexure and maximum bending moment. Thus, Fig. 2 shows the cross-section of a through bridge in which the floorbeams are riveted to the intermediate posts. The deflection of the floorbeam due to the load it carries causes it to bend, and this in turn bends the post, as shown. The top of the post may be partially fixed by the bearing of the two webs on the pin there. The length "l" in this case is considerably more than ½ L, so that even the pivoted end formula does not give results in error on the safe side. This bending of the posts by the floorbeam is clearly shown in many extensometer measurements on bridges under traffic. The deflection of the stringers also causes bending of the posts in the other direction, thus reducing the safety-factor of the pin-end formula in that direction.

Fig. 3 shows the elastic line of the columns of a tower in which the strut connections are assumed to be hinged and the loads all concentric. The points of contraflexure will fall nearly at the strut connections, and the condition is as near to that of pivoted ends perhaps as we can find in practice. The lower story column may be partially fixed at the bottom by flat bearing. If the struts are riveted to the columns they will lend some stiffness at these points, but not sufficient to produce fixed ends unless the struts be abnormally heavy and the connections very large.

Fig. 4 shows the elastic lines of the columns in a building where the girders are deep and are riveted to the columns. Here again the length l is equal to or greater than ½ L, instead of being ¼ L, as is assumed when the flat-end formulas are used.

These examples might be extended indefinitely,

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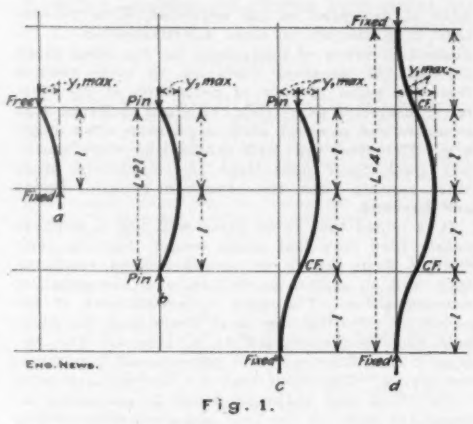

Fig. 1.

but enough have been given to illustrate the point in question.

The difficulty of fixing the end of a column in practice may be shown by calculating the angle through which a practical pin-end column will turn when subjected to a load. Take for example a pin-end column 400 ins. long, composed of two 10-in. 20-lb. channels, subjected to a load of 119,500 lbs. applied with an eccentricity of ¼-in. This column is more slender than good practice would allow, and the load is extreme. The theoretical deflection of this column at the middle is 0.23-in. and the angle of the tangent to its elastic curve at the end is 0° 7' 12", or a slope of 0.025-in. per ft. Now, if this column had a base-plate and shoe riveted to it, instead of a pin end, and were resting on a masonry support which was out of level only so much as 1/40-in. per ft., the flexure would be the same as for a pin-end column; if the error in level were more than this amount the flexure would be greater.

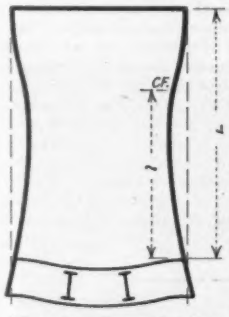

Fig. 2. Cross-Section Diagram of Bridge Under Load, Illustrating Distortion of Posts.

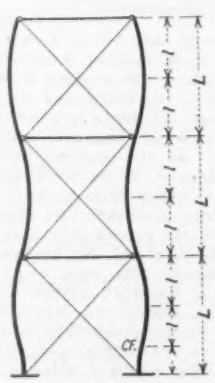

Fig. 3. Distortion Diagram of Braced Tower.

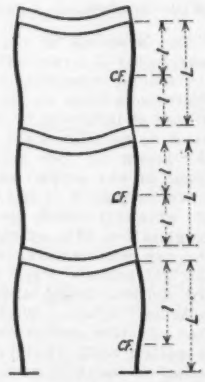

Fig. 4. Effect of Floorbeam Bending on Columns in Tier-Building.

In the discussion so far the columns have been considered as having no imperfections themselves. Neither this condition nor the condition of central loading is possible of fulfilment in practice or even in tests in the laboratory.

All imperfections in the columns, unavoidable eccentricities of application of the load, and uncertain end conditions, might be taken care of by considering the load to be applied with a certain eccentricity. The difficulty is in assigning a rational value to this eccentricity. Mr. J. M. Moncrieff in his paper* "The Practical Column under Central and Eccentric Loads" has collected the records of a great many experiments and from these has carefully estimated the probable limits within which the "accidental eccentricity" will fall. Figs. 5 and 6 show the results of most of the experiments given together with his upper and lower limit curves. In practically all cases the tests of round-end or pivoted-end columns fall above his lower limit curve for this class, but in nearly all of his diagrams showing tests of *fixed-end or flat-end* columns a great number of tests fall below the lower limit curve for fixed-end columns, showing that even in laboratory experiments the condition of fixity of the ends cannot be met.

The series of experiments made by the Pennsylvania Lines West of Pittsburgh on full-size bridge members, and published by Mr. C. P. Buchanan in Engineering News, Dec. 26, 1907, gives opportunity for determining the accidental eccentricities with considerable accuracy for columns with either pin ends or flat ends. In these tests the deflections at the middle of the columns were measured in both directions for each application of the load, and from these measurements the necessary accidental eccentricity of the load may be figured.

The equation of the load-deflection curve* is:—

$$Y_{max} = e\ (\sec \theta l - 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

in which

Y_{max} = Maximum deflection.

e = Eccentricity of load.

$$\theta = \sqrt{\frac{P}{EI}}$$

P = Load on column.

E = Modulus of Elasticity.

I = Moment of inertia.

l = Distance from point of maximum moment to point of contraflexure.

This is the equation of a curve involving the two variables P, the load, included in θ; and Y_{max}, the deflection of the column. It is applicable to any of the columns shown in Fig. 1 if a suitable value of l be used.

In Buchanan's tests above referred to, l will be taken as $\frac{1}{2}L$ for deflections normal to the pin and as $\frac{1}{4}L$ for deflections parallel to the pin. This is in accordance with the theory of the pivoted-end and fixed-end columns respectively. It must also be remembered that for the fixed-end calculations half the measured deflection must be taken. (See Fig. 1d.)

If in eq. (1) above, we replace e by $e_o + \Delta e$, where e_o = known intentional eccentricity of loading, Δe will include all uncertainties of loading and end conditions to which attention has already been called; that is, Δe is the equivalent accidental eccentricity. From the nature of the case Δe cannot be predicted by theory, but it may be determined for each of the columns in the above mentioned set of tests by the method of least squares, as follows:

Let e_o = intentional eccentricity, which is zero for a centrally loaded column.

Y_c = computed theoretical value of maximum deflection.

$= e_o\ (\sec \theta l - 1)$ by eq. (1).

Y_o = observed maximum deflection.

Δe = accidental eccentricity.

ΔY = deflection caused by Δe.

$= Y_o - Y_c$.

Then $Y_o - Y_c = \Delta Y = \Delta e\ (\sec \theta l - 1) \quad \ldots\ldots\ldots (2)$

$$= \Delta e\ \left(\frac{Y_c}{e_o}\right) \quad \ldots\ldots\ldots (3)$$

There will be a value of ΔY for each observation of Y_o.

Let

$\Delta Y_1 \Delta Y_2 \Delta Y_3 \ldots$ etc. = these observed values of Y_o

$a_1\ a_2\ a_3 \ldots$ etc. = the corresponding values of $\left[(\sec \theta l - 1) = \frac{Y_c}{e_o} \right]$

Then $\Delta Y_1 = a_1\ (\Delta e)$

$\Delta Y_2 = a_2\ (\Delta e)$

$\Delta Y_3 = a_3\ (\Delta e)$ etc.

*Trans. Am. Soc. C. E., Vol. XLV, page 334.

*See Heller's "Stresses in Structures," Art. 106.

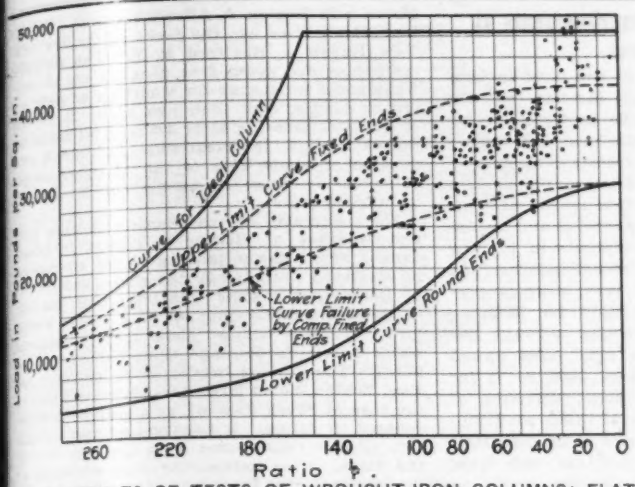
Curve for Ideal Column
Upper Limit Curve Fixed Ends
Lower Limit Curve Fixed Ends
Lower Limit Curve Failure by Comp. Fixed Ends
Lower Limit Curve Round Ends
Load in Pounds per Sq. In.
Ratio l/ρ

FIG. 5. RESULTS OF TESTS OF WROUGHT-IRON COLUMNS; FLAT AND FIXED ENDS.
[After J. M. Moncrieff.]

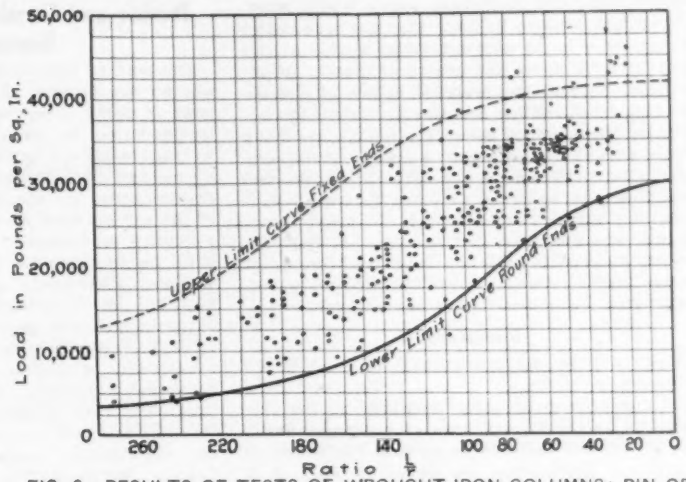

FIG. 6. RESULTS OF TESTS OF WROUGHT-IRON COLUMNS; PIN OR HINGED ENDS.
[After J. M. Moncrieff.]

Each of these equations will give a different value of Δe, so by least squares

$$\Sigma a a\ (\Delta e) = \Sigma a\ (\Delta Y)$$

$$\Delta e = \frac{\Sigma a\ (\Delta Y)}{\Sigma a^2} \quad \ldots\ldots\ldots (4)$$

The probable error of the result is

$$r_{\Delta e} = 0.67 \sqrt{\frac{\Sigma v^2}{(n-1)\ \Sigma a^2}} \quad \ldots\ldots (5)$$

$= \Delta Y - a\ (\Delta e)$.

n = number of observations.

In which v = the residuals of ΔY.

In computing the values of the accidental eccentricity only those loads were used which gave little or no permanent set in the column and were therefore less than the elastic limit.

The calculations for Column No. 18 given by Tables I. and II. will illustrate the method of computation, and Table III. gives a summary of the results for all the tests.

The column numbers used in the published data have been retained.

For Cols. 1 to 4 inclusive the deflections were not measured. In Table III. "Chd" stands for top-chord section with one cover-plate, laced on the bottom. Col. 9 was an intermediate post of four angles laced. Col. 17 was an intermediate post of four angles and two plates forming two built channels laced.

Specimen deflection diagrams for these columns are given in Figs. 7 and 8. These show the load deflection curves in each direction, for Cols. 5 and 9 respectively. In each case the broken line represents the measured deflections, the full line curve the theoretical deflections neglecting the accidental eccentricity, and the dotted curve the theoretical deflections using the accidental eccentricity.

There are several points noteworthy in the results of this series of tests. First, all of the accidental eccentricities normal to the pin in the chord sections, except one, are positive, which means that the accidental eccentricity increased the intentional eccentricity, giving a greater de-

TABLE I.—CALCULATION OF ACCIDENTAL ECCENTRICITY FOR COLUMN NO. 18, DEFLECTIONS NORMAL TO PIN.

A = 32.11 sq. ins.; r = 7.29 ins.; e_0 = 0.64-in.; L = 20 ft. 9 ins.; l = 124.5 ins.
Type, Chord section. Material, Steel. E = 29,600,000 lbs. per sq. in.

$\frac{P}{A}$	y_c	a	Δy	$a\ (\Delta y)$	a^2	$a\ (\Delta e)$	v	v_2
2.0	0.010	0.015	0	0	0.000225	0.011	—0.011	0.000121
4.0	0.020	0.030	0.043	0.00129	0.000900	0.021	+0.019	0.000361
6.0	0.030	0.046	0.050	0.00230	0.002116	0.033	+0.017	0.000289
12.0	0.040	0.062	0.056	0.00347	0.003844	0.044	+0.012	0.000144
15.0	0.051	0.078	0.056	0.00437	0.006084	0.056	0	0
18.0	0.062	0.096	0.064	0.00615	0.009216	0.069	—0.005	0.000025
21.0	0.073	0.113	0.078	0.00881	0.012769	0.081	—0.003	0.000009
24.0	0.084	0.131	0.086	0.01127	0.017161	0.094	—0.008	0.000064
				0.03766	0.052315			0.001013

Accidental eccentricity $\Delta e = \frac{.03766}{.05232} = 0.720$ (+) in.

Probable error $r_{\Delta e} = 0.67 \sqrt{\frac{.001013}{7 \times .052315}} = 0.035$ in.

TABLE II.—CALCULATION OF ACCIDENTAL ECCENTRICITY FOR COLUMN NO. 18, DEFLECTIONS PARALLEL TO PIN.

A = 32.11 sq. ins.; r = 7.74 ins.; e_0 = 0; L = 20 ft. 9 ins.; l = 62.25 ins.
Type, Chord section Material, Steel. E = 29,600,000 lbs. per sq. in.

$\frac{P}{A}$	y_c	a	Δy	$a\ (\Delta y)$	a^2	$a\ (\Delta e)$	v	v_2
2.0	0	0.003	—0.005	—0.000015	0.000009	0.001	0.006	0.000036
4.0	0	0.007	—0.005	—0.000035	0.000049	0.002	0.007	0.000048
9.0	0	0.010	—0.005	—0.000050	0.000100	0.003	0.008	0.000064
12.0	0	0.013	+0.005	+0.000065	0.000169	0.004	0.001	0.000001
15.0	0	0.017	+0.005	+0.000085	0.000289	0.006	0.001	0.000001
18.0	0	0.020	+0.005	+0.000100	0.000400	0.007	0.002	0.000004
21.0	0	0.023	+0.010	+0.000230	0.000529	0.008	0.002	0.000004
24.0	0	0.027	+0.015	+0.000405	0.000729	0.009	0.006	0.000036
				+0.000785	0.002274			0.000195

Accidental eccentricity $\Delta e_1 = \frac{.000785}{.002274} = 0.345$ in.

Probable error $r_{\Delta e} l = 0.67 \sqrt{\frac{.000195}{7 \times .002274}} = 0.074$ in.

TABLE III.—SUMMARY OF ACCIDENTAL ECCENTRICITIES COMPUTED FOR BUCHANAN'S TEST COLUMNS.

Col. No.	Type.	Length L	Area A	Normal to pin. e_0	Rad. of Gyr. r	$\frac{L}{r}$	Acc. Eccen. Δe	Prob. error $r_{\Delta e}$	Parallel to pin. Rad. of Gyr. r_1	$\frac{L}{r_1}$	Acc. Eccen. Δe_1	Prob. error $r_{\Delta e 1}$
5	Chd.	237.5	25.4	0.62	5.55	42.4	+0.116	0.017	7.07	33.5	0.507	0.053
6	"	175.2	22.8	0.52	4.88	36.0	+0.027	0.017	5.78	30.3	0.195	0.028
7	"	223.4	27.95	0.48	5.69	39.3	+0.104	0.015	7.04	31.7	1.083	0.035
8	"	223.4	27.95	0.48	5.69	39.3	+0.728	0.027	7.04	31.7	2.539	0.093
10	Chd.	289.2	14.22	0	3.10	96.7	0.072	0.003	4.81	62.4	0.973	0.042
11	"	289.2	28.38	0.62	6.34	45.6	+0.042	0.011	8.01	36.1	1.645	0.026
12	"	289.2	28.2	0.62	6.33	45.6	+0.032	0.060	8.01	36.1	0.972	0.039
13	"	184.0	27.46	0.68	5.65	29.0	+0.667	0.056	7.00	23.4	0.384	0.062
14	"	242.3	27.28	0.39	5.80	41.8	+0.437	0.008	6.93	35.0	1.540	0.063
15	"	190.2	21.78	0.95	4.71	40.4	+0.115	0.031	6.28	30.3	0.714	0.055
16	"	249.0	30.81	0.38	6.51	38.2	+0.127	0.008	7.08	35.1	2.408	0.040
17	Post	279.0	29.36	0.74	6.44	43.3	—0.007	0.022	7.80	35.8	1.714	0.211
18	Chd.	168.0	15.8	0	3.72	45.2	0.396	0.042	7.72	21.8	2.188	0.075
19	"	249.0	32.11	0.64	7.29	34.2	+0.720	0.035	7.74	32.2	0.345	0.074
		249.0	32.16	0	7.20	34.6	+0.178	0.011	7.74	32.2	0.418	0.028
					Average.....		0.251	0.024			1.175	0.062

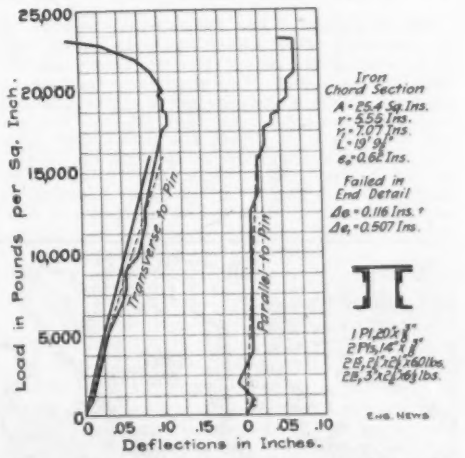
Load in Pounds per Sq. Inch.
Transverse to Pin
Parallel to Pin
Iron Chord Section
A = 25.4 Sq. Ins.
r = 5.55 Ins.
r1 = 7.07 Ins.
L = 19' 9"
e0 = 0.62 Ins.
Failed in End Detail
Δe = 0.116 Ins.
Δe1 = 0.507 Ins.
1 Pl. 20"x 1/2"
2 Pls. 14" x 1/2"
2 ∠s, 2 1/2" x 2 1/2" x 6 1/2 lbs.
2 ∠s, 3" x 2 1/2" x 9 1/2 lbs.
Eng. News
Deflections in Inches.

Fig. 7. Observed and Averaged Bending Curves for Col. 5 of C. P. Buchanan's Tests.

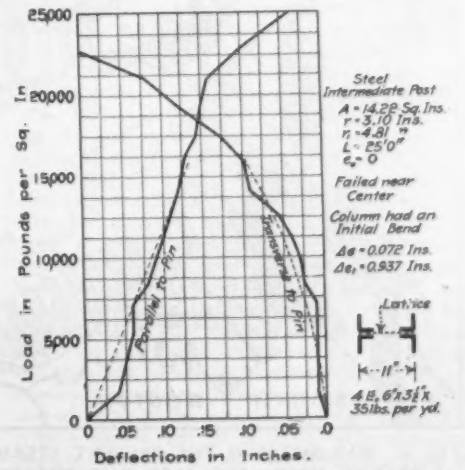

Fig. 8. Observed and Averaged Bending Curves for Col. 9 of C. P. Buchanan's Tests.

flection than the theoretical curve would show. This would seem to indicate that the true center of resistance in an unsymmetrical section of this kind is really above the center of gravity of the section. Second, the probable errors of the accidental eccentricities are small. Third, the accidental eccentricities parallel to the pin are many times greater than those normal to the pin. This is of course due to the difference in the end conditions, as there is no more reason to suppose any greater curvature of the graviyt axis in this direction than in the other. Fourth, the actual measured deflection and the theoretical curves agree closely, when the accidental eccentricities have been taken into account.

Summary.

The foregoing discussion may be summarized as follows:

1. Connections of other members to the columns cause the flexure lines of otherwise fixed-end or flat-end columns to assume the shape of a pin-end flexure line, as shown in Figs. 2, 3 and 4.

2. The diagrams of tests given in Mr. Moncrieff's paper show that the tests of flat-end or fixed-end columns fall farther below the theoretical values than do those of pin-end or pivoted-end columns, as shown in Figs. 5 and 6.

3. The Pennsylvania tests given above show that the accidental eccentricities for flat-end columns are much larger than for pin-end columns.

In view of these facts it would seem to the writer that the column formulas for fixed-end columns should be used with great caution and only when great care has been taken to fix absolutely the end of the column. Consequently it would be well to omit the formulas for fixed-end columns from handbooks and specifications, which should not be but often are used by men who do not realize the limitations which should be placed upon their use.

The Drainage of the Fresh-Water Portion of the Neponset River, above Mattapan, Mass., was authorized by the 1911 session of the Legislature of the State named. The work is to be done by the State Board of Health, and a sum of $150,000 has been appropriated for the purpose. The object is to drain the "Fowl Meadows," some 3,600 acres of low, wet meadow lands along the Neponset River above Hyde Park. Mr. X. H. Goodnough, M. Am. Soc. C. E., is Chief Engineer of the Massachusetts State Board of Health.

Harbor and Terminal Improvements at Boston, Mass.

The port of Boston is one of the most important on the Atlantic coast, but (as has been the case at many other ports) the provision of accommodation for shipping has been left mainly in the hands of private interests. Such provision has been largely inadequate for modern requirements, but the destruction by fire of some of the old property gave an incentive and an opportunity to construct improvements in keeping with the demands for better accommodation. As at many other ports, also, a very large proportion of the waterfront available for shipping purposes has been acquired by the railways and other private interests. The only piers owned by the city of Boston are those used by it for municipal purposes. The foreign commerce of Boston in 1910 amounted to a value of $190,931,000, but this was 4½% less than for 1909; the transhipment trade of goods to and from Canada increased the total foreign trade to $226,339,400. The customs receipts also were $27,114,500 in 1910 as against $30,954,300 in 1909. The number of foreign vessels entering the port was 1,363, or about 30 less than in 1909, but the net tonnage of these vessels was 85,883 tons greater, due to the increase in the size of ocean steamers. In addition to the transatlantic service, there is direct service with South America, India and Oriental ports. On the other hand, the coastwise service showed an increase in number of vessels without a corresponding increase in total tonnage. The transatlantic passenger service (of seven lines) shows 102,980 passengers for 1910 as against 90,920 in 1909.

The general conditions at this port are explained by the following extracts from the report of the U. S. Commissioner of Corporations on "Transportation by Water in the United States,"* and the situation is shown by the map, Fig. 1.

The situation of Boston on a group of peninsulas gives it a commodious harbor with a very extensive water front, thus far only partly developed. The outer harbor has numerous islands and shoals, between which several channels lead to the inner harbor. The work of deepening and widening the main ship channel is carried on by the United States Government. This 35-ft. channel, however, does not by any means open up all, nor nearly all, the water front to deep-draft vessels. Along the west and north shores of East Boston, a distance of over 2¼ miles, there are numerous wharves, but at only a very few does the depth of water in the docks exceed 15 ft., and at most of these it is less than 10 ft.

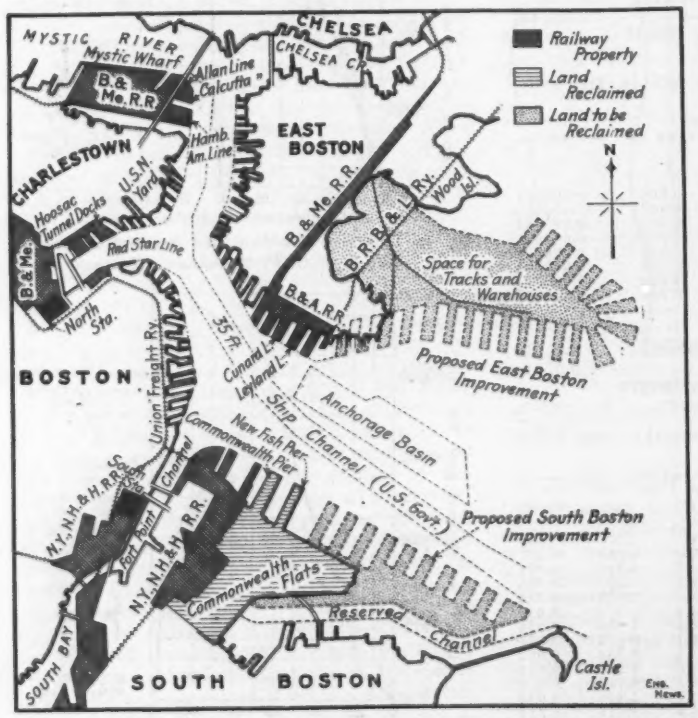

FIG. 1. MAP SHOWING THE PRESENT STEAMSHIP FACILITIES AT BOSTON, MASS., AND ALSO THE PROPOSED FUTURE DEVELOPMENTS.

Most of the harbor front within the business section available for ready transshipment purposes is occupied by almost continuous lines of wharves, mainly wooden structures built on piles and partly covered by wooden sheds. On many of the large wharves there are warehouses of brick and stone, most of them old, but with some new and substantial structures.

The steamship and steamboat wharves at Boston are about 8 miles from the open sea. None of the transatlantic steamship companies has its own piers and warehouses, but all use the railway terminals at Charlestown and East Boston, and most of their traffic goes over the Boston & Maine and Boston & Albany railways. No regular ocean lines use the docks of the New York, New Haven & Hartford R. R. The steamship companies are given free dockage and the railways make no charge for wharfage on goods going or coming over their own rails. In the case of goods originating at or destined for Boston, the railways allow the steamship companies a commission of about 25% of the wharfage charges collected by them as agents for the railways owning the piers.

The ownership of the commercial water front and wharves of Boston is largely in private hands. Small public landing places are reserved in scattered spots along the shore, and the city of Boston owns some wharf property, but only in isolated parcels and not as a unified system. The city owns almost none of the commercial water front, its holdings being largely used for parks. The State, however, at South Boston and East Boston, holds large areas of flats, which (in the case of South Boston) have been partially reclaimed by filling. It is estimated that probably 75% of this reclamation work has been done by the State. It is noteworthy that practically all the Boston water front was at one time flats, but the city has gradually encroached on the water. The land reclaimed in late years has been utilized mainly for parks, railway yards and sites for industrial and storage establishments. Large sections of water front and land adjacent are owned by railways, but much the greater portion within the older city and at East Boston is owned by parties other than railways. A large proportion of this latter class, as noted elsewhere, is of minor value to shippers on account of the shallowness of the water in the docks. By far the greater portion having ample dockage depth is owned by railways or occupied by steamship companies under leases.

The Union Freight R. R. extends from the yards of the Boston & Maine R. R., on Charles River near the North Station, along the water front to the New York, New Haven & Hartford R. R. and Boston & Albany R. R. yards at the South station, and is the only belt railway in the city of Boston. It is controlled by the N. Y., N. H. & H. R. R. system. The Union Freight R. R. is by no means as complete as the situation requires or permits. The total length of track operated is 5.33 miles. Of this trackage, 2.3 miles are main track, 0.83 mile second track and 2.2 miles consists of side tracks, of which 1.2 miles are owned by private parties. This railway connects with all the other railways in Boston and with seven wharves, including those of several important coast wise lines and lines running to the Canadian maritime provinces. The railway is being extended across Fort Point Channel from Northern Ave. to the N. Y., N. H. & H. R. R. yards.

In 1895 the legislature created a state board of docks and terminal facilities to inquire into the needs of Boston for an improved system of docks and wharves and terminal facilities, and into a policy of public ownership of docks and wharves. This board reported in 1897, its conclusion with reference to public ownership being:

> A portion of the foreshore should forever be preserved in the ownership and control of the people, for uses and purposes such as the needs of changing conditions may from time to time require, but it is neither necessary nor desirable that the entire foreshore of the harbor should be thus held. On the contrary, a diversified ownership is believed to be the healthiest, and therefore the acquisition of certain parcels within the limits of the city of Boston is recommended.

In 1907 the legislature directed the Board of Harbor and Land Commissioners to report on a system of metropolitan docks in the city of Boston, to be owned and controlled either by the State or by the city. The board reported, Dec. 1, 1907, that it did not think it advisable to construct and maintain a system of metropolitan docks in Boston at that time; although it stated that the time may come when such construction would seem advisable. The board also concluded that a system of public docks without railway connections would not help the situation, and said that if it is deemed advisable to construct a system of metropolitan docks the same should be connected by a marginal railway with all the railways entering Boston.

The report of the Metropolitan District Improvements Commission (March, 1909) states as to water terminals:

> The water terminals are mainly owned and controlled by the railways and other transportation lines. They are already becoming congested to the point of interfering with the dispatch and economy of business.—There should be adopted a comprehensive plan for a flexible and efficient system of interchange terminals, whereby commodities, whether in carload or cargo bulk, or in lesser lots, may be delivered and transshipped from railway to railway, or from land to water,

*Part III. "Water Terminals" (Sept. 26, 1910): U. S. Department of Commerce and Labor, Washington, D. C.

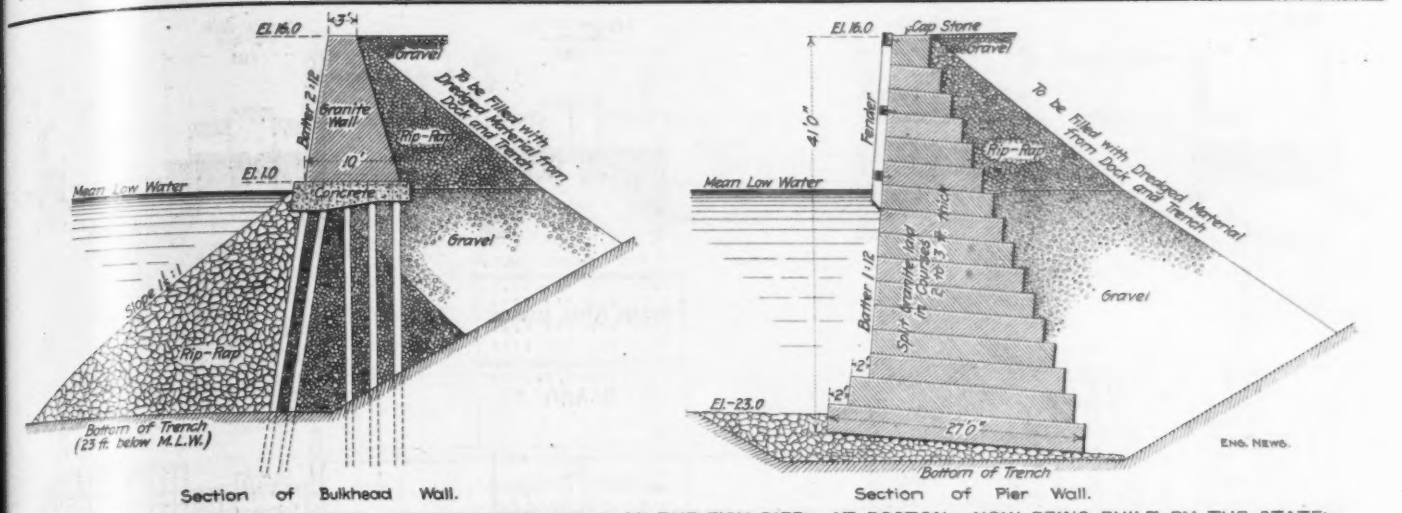

FIG. 2. CROSS SECTIONS OF THE PIER AND BULKHEAD WALLS OF THE FISH PIER AT BOSTON; (NOW BEING BUILT BY THE STATE).

or vice versa, and distributed among consignees, with the highest attainable expedition and economy.

The general distribution of the harbor development work at Boston is as follows: The U. S. government provides and maintains a ship channel from the upper part of the harbor to the ocean. The Massachusetts Board of Harbor and Land Commissioners undertakes the dredging outside of this channel; it also reclaims land for harbor purposes and builds piers, wharves, etc. The city's work should be to see that suitable pier sheds, warehouses, railway facilities, etc., are provided. As a matter of fact, the city has had little to do with this, the water front being owned mainly by railway and other companies, which build their own sheds, etc. The railway lines and facilities have developed piecemeal and do not form a systematic arrangement adapted for ready and economical transfer of freight. The matter of better shipping and railway terminal facilities has been investigated by various boards representing different commercial and other organizations, but progress in this direction has been slow.

The main ship channel, which is the work of the U. S. government, has a width of 540 ft. for about six miles from the Mystic and Charles rivers to President Roads (in the outer harbor), and 675 ft. from President Roads to Broad Sound and the ocean (about two miles). The general depth throughout this channel is 35 ft. at mean low water, but the upper part of the channel is obstructed by some rock ledges which are now being removed. The width is being increased to 1,200 ft. and 1,500 ft. for the upper and lower parts respectively, and it is expected that this will be completed by the end of 1911.

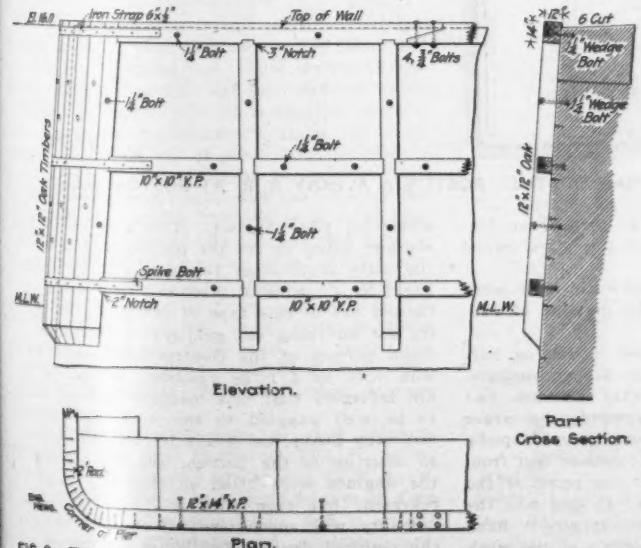

FIG 3. TIMBER FENDER FOR THE MASONRY WALLS OF THE FISH PIER.

The harbor is under the supervision and control of the Massachusetts Board of Harbor and Land Commissioners, which is a state authority having general care of the harbors, tidewaters and submerged lands (or flats) on the entire coast line of the State. Mr. Frank W. Hodgdon, M. Am. Soc. C. E., is Chief Engineer of the Commission. Through this commission, the State government has improved the harbor by dredging and by the construction of piers and docks. In doing so it has reclaimed and partly developed a large area of flats at South Boston (described below), and has acquired another large area at East Boston for future development. The dredging is mainly in the areas between the ship channel and the various piers and wharves, so as to facilitate the movements of ships; it includes also an anchorage basin in the harbor, at Bird Island (opposite South Boston), having an area of about 126 acres and a depth of 30 ft. at low water.

STATE PIERS.—At South Boston, a large tract of flats to the east of the railway piers has been reclaimed and filled by the Harbor and Land Commission. Here, about 11 years ago, the Commission built a large pier, known as the Commonwealth pier. This is of solid filling retained by masonry walls; outside of the walls is a timber platform 50 ft. wide, supported on piles, against which the vessels are moored. Including the filled space and the timber platform the pier is 1,200 ft. long and 400 ft. wide, and the depth of water in the slip is about 35 ft. (at mean low water). In 1909, the Boston Fish Market Association, which controls the fresh fish industry, made application to lease this pier for the use of the fishing vessels (which work mainly on the Newfoundland and Georges banks) in order to secure better accommodation. After conferences with the Harbor and Land Commission, however, it was decided that the requirement could be served better by a new pier (adjacent to the other) 1,200 × 300 ft., with 23 ft. of water. This is now under construction, the contractor being the Holbrook, Cabot & Rollins Co., of Boston. In 1910, this new pier (with some adjoining land) was leased to the Fish Market Association for a term of 15 years, beginning with 1913, when the pier is expected to be completed. Spur tracks from the N. Y., N. H. & H. R. R. will be laid on the pier.

This pier is composed of solid filling between walls of granite masonry. The walls (Fig. 2) are 41 ft. high, with the base (25 ft. below mean low water) resting on a bed of granite quarry chips or rip-rap stone deposited in a dredged trench. The walls are 27 ft. and 4 ft. wide at bottom and top respectively. No cofferdam is used in the construction, the lower part of the work being done under water by the aid of divers. The loose rock for the foundation is discharged from scows into the trench, and leveled to the required elevation by a diver. The two footing courses of the wall consist of headers, while alternate headers and stretchers are used for the upper courses. The blocks weigh from 5 to 15 tons and are handled by floating derricks, the divers adjusting them in position. Above the low water line the blocks are laid by stone masons. Against the face of the wall is placed a timber fender shown in Fig. 3. The gravel filling behind the wall is leveled by means of a scraper or sweep suspended from a scow which is hauled to and fro by cables.

A granite bulkhead wall of lighter construction and with pile foundation (Fig. 2) is built on the line of Northern Ave. (which is the water front street) for a distance of 645 ft. The trench for this was dredged to 23 ft. below mean low water, and five rows of piles were driven, with a penetration of at least 16 ft. These are capped with a concrete base for the wall. Small rip-rap stone and gravel are laid around and behind the piles, and coarse rip-rap is deposited on the water side.

PRIVATE PIERS.—Practically all the steamships in the foreign trade are berthed at piers and wharves owned and operated by the Boston & Albany R. R., and the Boston & Maine R. R. Coasting and other steamers use private piers along Atlantic Ave., between the Charles River and Fort Point channel. The depth of water at the railway piers and wharves is from 23 to 35 ft. at low water. Within the past few years all of the piers and facilities of the Boston & Albany R. R. (at East Boston) have been rebuilt, the larger part having been destroyed by fire in 1908. The new piers are on piles and have face walls, as described below.

The Boston & Maine R. R. has piers on the Charles and Mystic rivers. The piers at the mouth of the Charles River (Charlestown) are 310 to 630 ft. long, with docks 150 to 400 ft. wide between them. They are principally of pile construction. We are informed that although three of them have been burned and rebuilt within the past ten years, practically no attempt has been made to fireproof the flooring or any of the supporting structures; but the sheds are well protected by automatic sprinklers. The wharf on the Mystic River has one berth 1,200 ft. long and others of sufficient depth to accommodate ordinary steamers. These wharves are of solid filling retained by masonry walls, with a timber belt 30 to 50 ft. wide along the face of the wharf. At the three locations of these two railways the sheds are fireproofed to some extent. Each location also has grain ele-

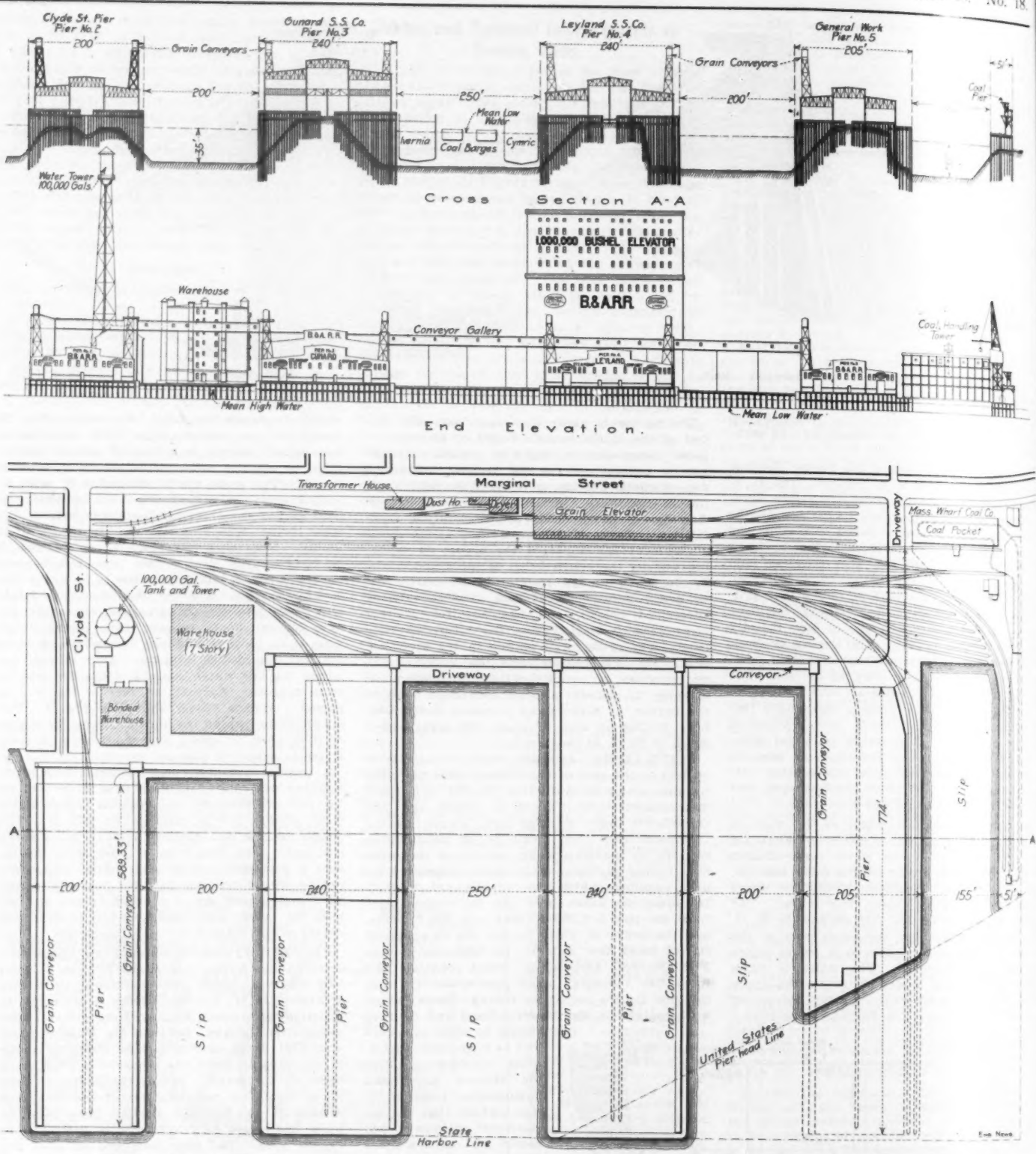

FIG. 4. PLAN AND ELEVATIONS OF THE RAIL-AND-WATER TERMINAL OF THE BOSTON & ALBANY R. R. AT BOSTON, MASS.

vators of comparatively recent construction, the one at the Mystic site replacing a larger one of wooden construction which was destroyed by fire.

The New York, New Haven & Hartford R. R. owns piers at South Boston, its property lying between Fort Point channel and the Commonwealth Pier (owned by the State). The property was formerly owned by the State, which also built part of the existing piers. The piers are from 770 to 1,050 ft. long, with 26 to 33 ft. of water at low tide. They are of solid fill construction, with masonry walls, and having on each side a pile and timber platform 30 to 60 ft. wide, next to the berth for vessels. There is no fireproofing in the timber structure. This railway has leased the Commonwealth pier, already mentioned, but at present no foreign steamers come to any of the piers owned or leased by this company.

None of the railways have now any new work or improvements under way in the line of rail-and-water terminals.

DREDGES.—The dredges used in Boston harbor are principally scoop or dipper dredges. Those used on the main ship channel had buckets from 5 to 12 yds. capacity; the larger dredges were pinned up on their forward spuds, which were equipped with platforms or feet from 9 to 12 ft. square, fitted near the point of the spud with large shafts or pins. In this way the dredge hull was made a practically steady fixed platform when dredging. A portion of the work was done by a ladder dredge having buckets of about 1½ yds. capacity. This was an old lake steamer fitted up for the purpose and owned by the Daly & Hannan Dredging Co., of Ogdensburg, N. Y.; it is of interest owing to the very limited use of this type of dredge in this country for anything but gold-gravel excavation. A small portion of the Government channel work was done by a large clamshell dredge, but we are informed that this machine was not found to be well adapted to the work. The bucket was very heavy, too heavy in fact to be allowed to drop on to the bottom, and for lowering it the engines were fitted so that they could be reversed; but even with this heavy apparatus difficulty was encountered at times in securing the required depth. Smaller dipper dredges are used on the smaller jobs around the harbor,

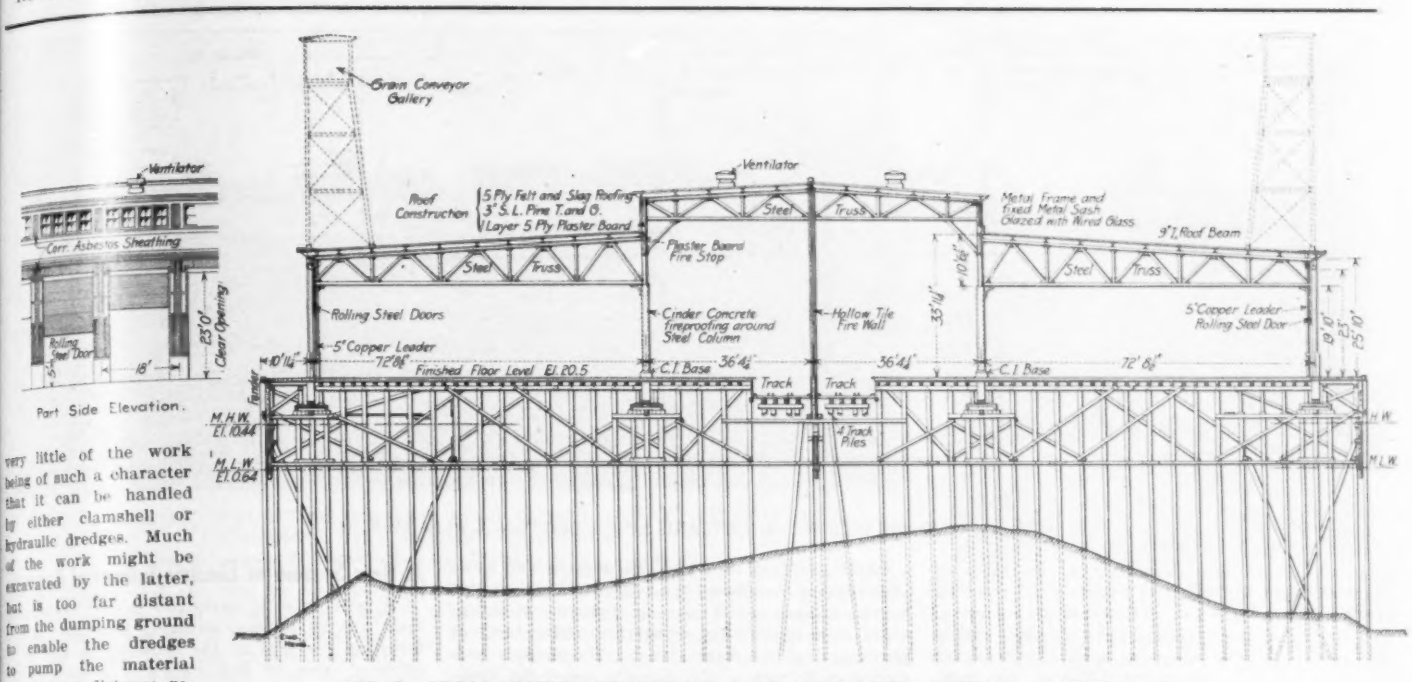

FIG. 5. CROSS SECTION OF PIER NO. 4 (LEYLAND LINE); BOSTON & ALBANY R. R.

very little of the work being of such a character that it can be handled by either clamshell or hydraulic dredges. Much of the work might be excavated by the latter, but is too far distant from the dumping ground to enable the dredges to pump the material for the long distance required.

New Rail and Water Terminal of the Boston & Albany R. R.

One of the most important improvements in harbor facilities at Boston is the reconstruction of the rail and water terminals of the Boston & Albany R. R. at East Boston, as the result of the destruction of a large part of the old works by a fire in July, 1908. The new terminal provides accommodation for the largest class of ocean steamers. It covers a length of about 1,800 ft. of water front, and has a depth of about 1,100 ft. from the pier head line to Marginal St. (which parallels the water front). About 300 ft. of this width is solid ground between the street and the bulkhead line, and here are located the grain elevator and the railway sidings, the latter having spurs extending along the piers. There are five piers in all, including one which is only 50 ft. wide. The others are 200 × 650 to 240 × 780 ft. The docks or slips between the piers are 200 and 250 ft. wide (except one, which is only 155 ft.), and have 35 ft. of water at low tide. The reconstruction since the fire of July, 1908, has included three piers, the railway yard and sidings, a grain elevator of 1,000,000 bushels storage capacity, and a system of conveyors for delivering grain to the steamer berths. The total cost of this work has been about $4,000,000. A plan and elevation of this terminal is shown in Fig. 4.

The piers are mainly of pile construction, but with a solid fill near the center for about 400 ft. from the bulkhead line, as is shown by the cross sections. As there are no retaining walls, however, the top of this fill is narrow, so that the slopes may not encroach upon the dock space. The sheds are of steel frame construction, and are of such width as to leave a width of 10 ft. between the shed and the edge of the pier. This 10 ft. space has a floor of reinforced concrete. The face of the pier is closed by a solid wall to serve as a fire stop, and to prevent burning oil or other debris from floating under the pier and setting fire to the piles and flooring. This face wall is of concrete slabs extending from the floor level to mean low water line, below which it is of timber. Exterior piling protects this work from damage by vessels.

The sheds have four rows of steel columns supporting steel roof trusses of 73½ ft. span; the columns and trusses are spaced 18 ft. apart longitudinally. Fig. 5 is a cross section of Pier No. 4 (Leyland Steamship Line), and is typical of the pier substructure and superstructure. Fig. 6 is a section of the two-story portion of the shed on Pier No. 3 (Cunard Steamship Line); the upper floor is for passenger accommodation, and has facilities for the inspection of immigrants. Fig. 7 is a floor plan of Pier No. 4 (Leyland Line), showing the arrangement of fire-walls, etc., for sectionalizing or subdividing the interior space. On the main floor of the piers the clear headway is 17 ft. in the side spans and 30 ft. in the central span. For about 400 ft. from the shore end, however, the shed No. 3 has an upper floor, as noted above and as shown in Fig. 6; this is carried by steel trusses in the center span and by plate girders in the side spans, with I-beam joists placed longitudinally. The columns and these floor trusses and girders are encased for fire protection. The column footings consist of a grillage of 10-in. I-beams and 12 × 12-in. timbers upon a cluster of piles. A central partition and transverse partitions divide the main floor into compartments, the openings in these walls being fitted with automatically closing fire doors. The fire service includes a sprinkler system and hose connections with high-pressure fire protection service installed by the railway company.

The main floor has joists 4 × 12 ins., 16 ins. apart, covered with 3 × 8-in. plank; on this is a layer of fireproof plaster board and then the ⅞-in. spruce under-floor with 2-in. spruce wearing surface. In the center of this floor is a depressed portion for the two railway tracks; this is 4 ft. deep, and its sides are faced with vertical concrete slabs. Ventilation is provided for the enclosed space beneath the floor. The second floor (on Pier No. 3 only) has 4-in. planking secured by wire hooks to the flanges of the 12-in. I-beam joists; on this is a layer of fireproof felt and then the wearing surface of ⅞ × 4-in. maple plank. This floor is designed for a load of 125 lbs. per sq. ft. The roof has purlins of 9-in. I-beams, sheathed with plaster boards and 3-in. plank, and having a roofing of asphalt composition and slag. The exterior walls are mainly of corrugated asbestos sheathing, while the lower floor has rolling steel doors in every panel.

The grain elevator (fronting on the street) is 73 x 270 ft. It can handle grain at a rate of 20,000 bushels per hour in unloading and 40,000 bushels per hour in loading. It has two unloading tracks. For delivering the grain to ships there is a system of belt conveyors in galleries about 65 ft. above the level of the piers. Two inclined galleries extend from the elevator across the railway yard to a gallery along the bulkhead line; from this latter six

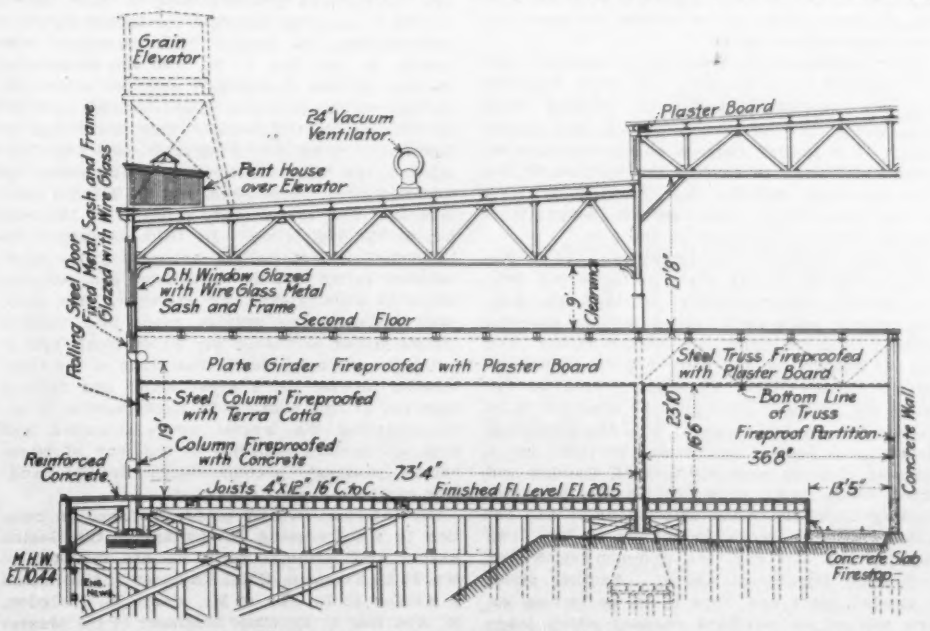

FIG. 6. HALF-CROSS SECTION OF DOUBLE-DECK PORTION OF PIER NO. 3 (CUNARD LINE); BOSTON & ALBANY R. R.

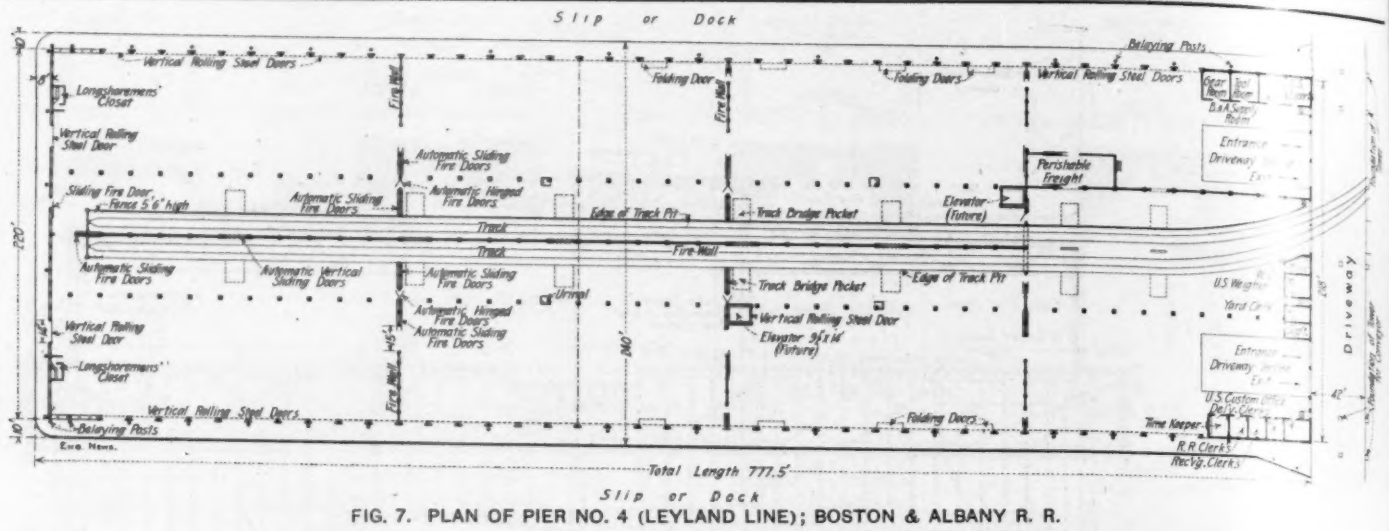

FIG. 7. PLAN OF PIER NO. 4 (LEYLAND LINE); BOSTON & ALBANY R. R.

galleries extend along (and above) the sides of the pier sheds, as shown in Fig. 5. The galleries are 9 × 12 ft.; they are of fireproof construction, with steel framing, concrete floor, asbestos siding and tile roof. The conveyor belts are 24 to 36 ins. wide and run at about 1,200 ft. per min. Each belt can carry about 10,000 bushels per hour, and the grain can be discharged from the belt at any desired point (to a chute leading to the steamer's hatchway) by means of a portable tripper. All the machinery is electrically operated, as described in Engineering News, April 6, 1911.

Future Improvements.

The State Harbor Commission has planned an extensive scheme of improvements at South Boston and East Boston; the work will involve the reclaiming of flats or tide lands for the purpose of piers and other facilities for shipping and railway terminals. The general plans for both sites are shown on the map, Fig. 1, and it will be seen that together they provide for a very comprehensive and systematic arrangement. It is thought that the work at South Boston will be carried out practically as shown, but that material modifications may be made in the plans for East Boston. On July 29, 1911, Gov. Foss signed a bill authorizing an issue of $9,000,000 of state bonds, to be expended on this development. The funds are to be expended by a board of five commissioners, one of whom is to be an engineer and is to devote all of his time to this work. The four other commissioners may be laymen and are expected to devote only a portion of their time. The Chairman will receive $15,000 per year, and each commissioner $1,000.

The Commission has pointed out, however, that the building of large piers and deep channels will not necessarily result in bringing large steamers to this port, which already has unused piers. It is for the citizens and commercial interests of Boston to develop the business of the city, the State, and the New England territory, so that there will be passenger and freight business to attract steamships to the port.

SOUTH BOSTON.—The improvement of territory acquired by the State in the South Boston district was commenced in 1873, the general project being to fill the flats with material dredged from the upper part of the harbor. The hatched portion of the map, Fig. 1, shows the portion already filled, while the dotted portion shows the proposed piers and the area yet to be filled. The general plan of the Massachusetts Harbor and Land Commission, provides for a series of 11 large piers 900 to 1,200 ft. long and 300 ft. wide (with slips 275 to 300 ft. wide), fronting upon the main ship channel; the beginning of this series is formed by the two piers at the east end, the Commonwealth and Fish piers (mentioned above). Another series of smaller piers and slips is to be formed on each side of an auxiliary channel which leads from the main channel (at Castle Island) to the rear part of the filled area.

EAST BOSTON.—In 1898, the Harbor and Land Commission purchased and acquired about 100 acres of land and flats near Jefferies Point, in order to secure public ownership and control of that part of the water front. Its purpose was stated as follows in the Board's report for 1908:

> The Commonwealth has dedicated another section of the harbor front to the use of maritime commerce, and has confirmed the policy of encouraging the growth of this port by taking measures to meet growing demands for enlarged accommodation, while preserving conditions which will operate against increase of cost in supplying facilities for handling cargoes in process of transportation or for local delivery. In order that this acquisition may realize the greatest possible benefit to the public, it will be necessary for the railways with freight terminals in East Boston to relocate their tracks on the east side of the island, as was advocated in the report of the State Board on Docks and Terminal Facilities in 1896, and by the mayor of Boston in 1897. By so doing a short, cheap and easy rail connection can be made to the piers and docks to be established on the newly acquired territory by the group of railways having terminals on the north side of the harbor.

Development of this property was delayed by questions in relation to title and by negotiations for the relocation of the East Boston tracks of the Boston & Albany R. R., which obstructed access to this site, but the outcome was that the tracks were allowed to remain. Two years ago a report was made by a special commission on metropolitan improvements, and one of its recommendations was that a large area of flats and unimproved property east of East Boston should be acquired and held for harbor and dock improvement, as needed. Mr. Desmond Fitzgerald, M. Am. Soc. C. E., was the engineering member of this commission and the recommendations for these harbor improvements were due to his study of the matter. This report was referred to a Board consisting of the Railway Commission, the Metropolitan Park Commission, the Boston Transit Commission and the Harbor Commission. This Board made a report on the matter to the legislature. In 1910, therefore, the legislature passed an act authorizing the Commission (after certain conditions are complied with) to acquire land for extending this property eastward, to provide roads and railway tracks giving access to the water front, and to build the proposed piers. The plans of the Commission provide for a great water and railway terminal at this point, with piers capable of accommodating the largest ocean steamers, and with all modern facilities in the way of warehouses, passenger accommodation, freight handling equipment, etc.

For information and plans furnished in relation to the foregoing particulars of the Boston harbor and terminal work we are indebted to Mr. F. B. Freeman, Chief Engineer of the Boston & Albany R. R., and to Mr. Frank W. Hodgdon, M. Am. Soc. C. E., Chief Engineer of the Massachusetts Board of Harbor and Land Commissioners.

A New System of Electric Industrial Railway.

A new type of industrial railway which has been put in service, presents a number of interesting features in the construction and operation of lines of this class. It is operated by electricity and provides for automatic control of the car movements, while a special feature is the use of the track rails as electrical conductors. Further, the system dispenses with grading and ordinary track construction.

The substructure consists of a single row of posts of 4-in. to 6-in. wrought-iron pipe set in concrete footings. These are of length varying with the grade and topography, but long enough to keep the track well out of the way of snow. Figs. 1 and 2 show the line on high and low posts, with trains of motor and trail cars in each view. Each post carries a cross-piece or yoke of malleable iron having supports at its ends to receive the insulated brackets for the rails. The gage of the track is 30 ins. The posts are about 15 ft. apart.

The rails are of special section, approximately channel shaped, and weighing 30 lbs. per yd. They are in lengths of 30 ft. The joints are spliced by fish-plates and electrically bonded by copper wire. The rails are bolted to brackets on the yokes, these being insulated from the latter, as shown by the cross section in Fig. 3. One rail is the conductor and the other serves for the return circuit. On the car there are two hinged brush holders, each carrying a metallic brush which makes contact with the inside of the rail, being held up against it by a spring. The motor is compound wound, of special design and made by the company. It has a rated capacity of 6 HP. The motor is mounted on one of the two axles, and drives it through bevel gears. Direct current at 220 volts is used.

The motor is at one end of the car, and at the other end is an automatic track brake. This brake is set at the top of the grade by means of an arm making contact with a trip attached to the rail; this throws into gear a cone clutch by means of a heavy spring, and the clutch revolving winds up a wire rope which pulls on a lever and sets four brake shoes or slippers on the rail (Fig. 4). At the bottom of the hill or grade an inclined bar 10 or 12 ft. long, acting as a cam, is fastened to the track supports and forces out the clutch lever so as to release the clutch and allow the brakeshoes to be withdrawn from the rail.

The cars are designed to be operated by hand by an ordinary controller, or automatically by means of a controller of special design. For the latter method, a trip is placed on the rail at any point where it is desired to stop or reverse the motors. When the car reaches this point, and strikes the trip, the current is first cut off, then the motor is reversed and the current is again applied gradually, causing the car to return until another trip is reached, which either stops the car or again reverses it. The cars are wired as shown in the diagram, Fig. 5. The earlier cars

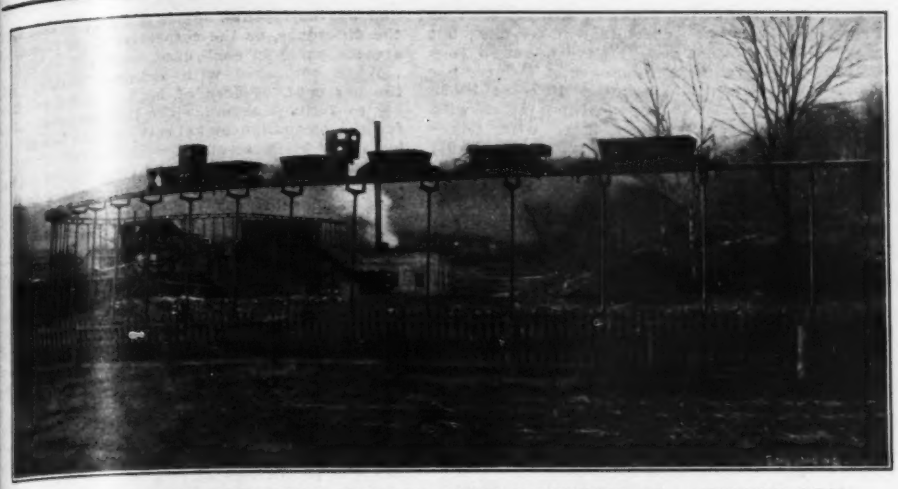

FIG. 1. ELECTRIC INDUSTRIAL RAILWAY, NEAR BLOSSBURG, PA.; BRINGING COAL FROM MINES TO A RAILWAY SHIPPING POINT.
The Automatic Transportation Co., Buffalo, N. Y., Builders.

had two axles at each end (Fig. 2), but the later cars have only one axle at each end (Figs. 1 and 3). The wheels are 12 ins. diameter on the tread and 11 ins. over the flanges; they are 4 ins. wide, with a 3-in. tread. The motor cars weigh 1½ tons and carry one ton load; the trail cars weigh 1½ tons and carry two tons of load. The cars for coal and ore are of hopper type, and at the discharging point the doors may be released, closed and locked automatically. They may be operated singly or in trains with as many as ten cars to a train. They have been tipple. On this line the motor cars are controlled by motormen, but the dumping of the cars is effected automatically. Each train consists of a motor car and four trail cars, and the round trip is made in about 15 mins. The power-house furnishes current for operating the railway, and its equipment includes a 50-KW. generator driven by a 75-HP. steam engine. The power house and the two coal pockets (one for loading railway cars and the other for the power plant) are shown in Fig. 1.

This is the only line yet built and in operation, but a 12-mile line is to be built in Colorado, in the Montezuma mining district. This length will include an 8-mile main line and several branches to mines.

The system here described is claimed to be specially adapted to lines of this class since no grading is required, steep grades can be operated with ease, and the cost of construction, equipment and operation compares favorably with other systems. It is adapted also for quarries and for industrial railways at manufacturing plants, etc. It is the invention of Mr. Wm. C. Carr, and is being introduced by the Automatic Transportation Co., of Buffalo, N. Y., Mr. Carr being President of the company.

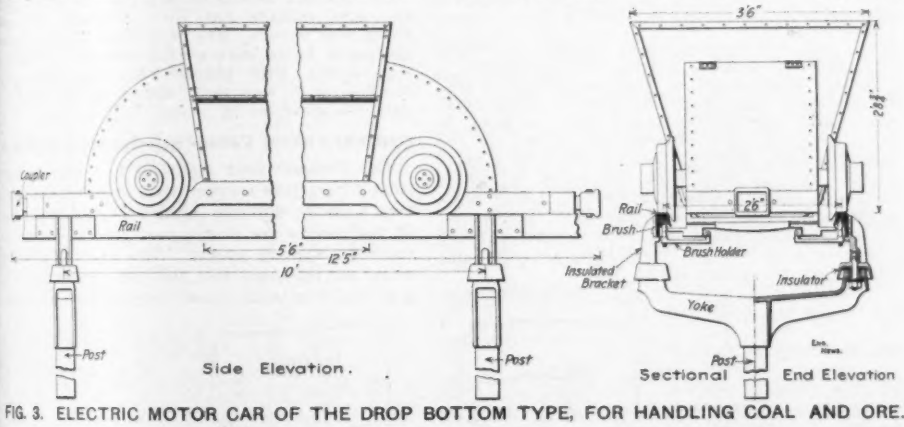

FIG. 3. ELECTRIC MOTOR CAR OF THE DROP BOTTOM TYPE, FOR HANDLING COAL AND ORE.

operated on grades as steep as 9%, with five-car trains, three of which were motor cars. The speed is about 12 m. p. h.

The first line built was at Blossburg, Pa.; this was built in 1910, and is still in operation. It was built to supersede a wagon service connecting the mines of the Nowak Coal Co. and Jenkins Bros. with the nearest railway. It is about one mile in length, with a total fall of 553 ft. from the upper mine tipple to the coal pockets from which the coal is delivered into the railway cars. The line is laid above the pockets and is about 30 ft. above the railway siding. From the tipple of the upper mine there is a grade of about 7½% to a short stretch of level at the next tipple, beyond which there is a grade of 7.8% for a distance of about 1,200 ft. to the lower end of the line. There the grade is reduced to 2½%, followed by an ascending grade of 2% to the power-house and

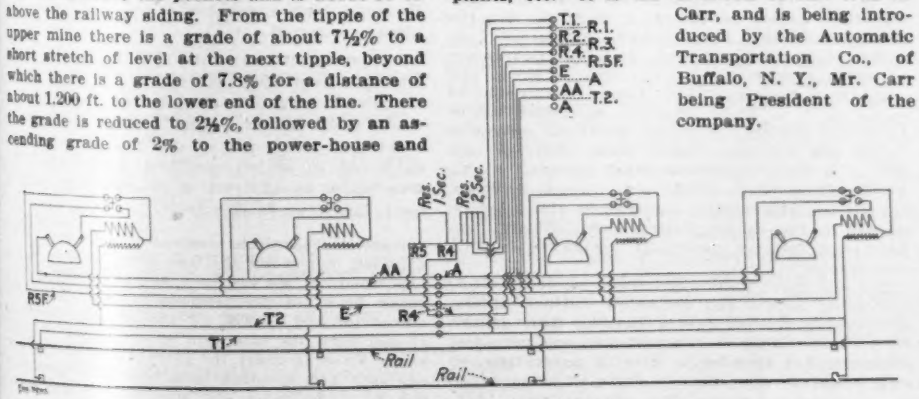

FIG. 5. WIRING OF MOTOR CAR.

Fig. 2. A Low-Level Portion of the Electric Industrial Railway.

The Additional Water-Supply for Jersey City, N. J., built under a contract with Patrick H. Flynn, of Brooklyn, N. Y., signed Feb. 28, 1899, and subsequently assigned to the Jersey City Water Supply Co., was formally transferred to Jersey City early in the present month (Oct., 1911). The works, which include a large masonry dam and storage reservoir at Boonton, N. J., and a steel supply main thence to Jersey City, were completed some years ago. Since then, the city has been buying water from the company. The original contract price was $7,595,000; the amount paid, after deductions resulting from litigation,

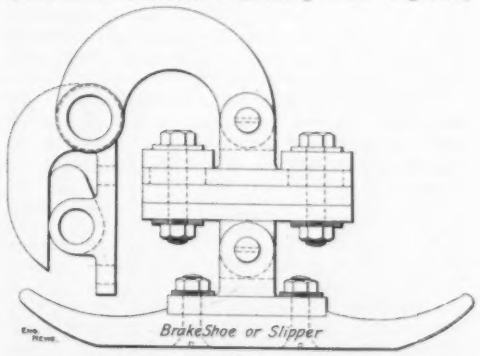

Fig. 4. Track Brake of Motor Car.

was $6,992,000. It is reported that the city has been paying $530,000 per year for water by the million gallons, and that now the annual charges will be substantially as follows: interest, $300,000; sinking fund, $101,000; maintenance, $20,000; total, $429,000. An outline of the so-called Flynn contract was published on p. 91 of our issue of Feb. 9, 1899, in the course of which it was stated that the Flynn bid was received at the eighth bidding for a new water-supply since Nov. 1, 1892 (see Eng. News., April 25, 1895, for lengthy editorial review of attempts to monopolize the water-supply of northeastern New Jersey).

A Competition for the Perry Memorial, which is to be erected at Put-in-Bay, South Bass Island, Lake Erie, has been announced by the committee in charge. The memorial will commemorate not only Perry's naval victory but the subsequent hundred years of peace between the United States and Great Britain. It is to consist of a lofty monument with a museum for historical relics at its base. A reservation of 14 acres will be laid out in a manner befitting the monument and museum. The problem presented is an attractive one, for the competitors will have full scope in designing both monument and grounds. The prize will be the appointment of the architect to design and superintend the erection of the memorial. Besides this three premiums will be awarded for the next best designs. The secretary of the building committee is Mr. Webster P. Huntington, Federal Bldg., Cleveland, Ohio, and Mr. Frank Miles Day, of Day Bros. & Klauder, Architects, of Philadelphia, Pa., is the professional adviser of the building committee.

The Wear of Rails of Different Grades of Steel.

The subject of rail wear and rail failures has required considerable attention on the part of railway engineers during the past few years, owing to the increased loads and service imposed upon the track and the numerous cases of failure and excessive wear which have developed in modern heavy rails. The trouble appears to lie in the character or quality of the steel, and the methods of manufacture, more than in the service to which the rails are subjected. The Rail Committee of the American Railway Engineering Association has done much valuable work in investigating the conditions as to rails and their service, experimenting in lines of possible development, and suggesting improvements in both rail specifications and rail manufacture.

Among the investigations conducted by this committee have been close inquiries as to rail failures, their causes, and the deductions to be drawn from them. Extensive records of such failures have been compiled, and the latest results in this direction are presented in a recent bulletin.* A statement regarding the investigations is accompanied by a number of statistical diagrams, and these, taken together, give detailed information as to results with rails of different steels, sections and weights.

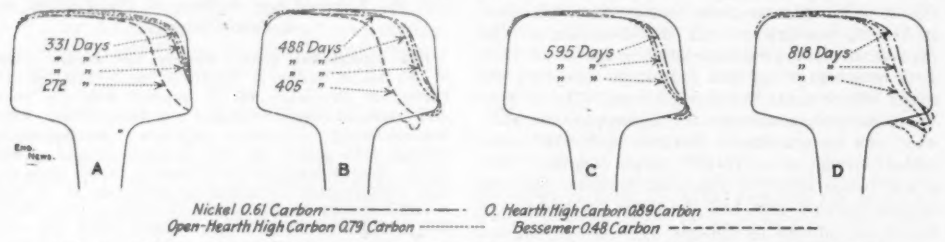

FIG. 1. SECTIONS SHOWING RELATIVE WEAR OF RAILS OF DIFFERENT GRADES OF STEEL ON A 6 DEGREE CURVE (OUTER OR HIGH RAIL); PENNSYLVANIA R. R.

The relation of phosphorus to carbon is a very important feature in regard to the quality of steel for rails, and a summary of the relations prescribed for the rails under investigation is as follows:

Phos., P. ct.	Car, P. ct.	Phos., P. ct.	Car, P. ct.
0.10	0.43 to 0.58	0.04	0.63 to 0.76 (& 0.80)
0.085	0.55 to 0.65	0.03	0.70 to 0.85
0.06	0.55 to 0.68		

Comparison between different weights and sections of rails of Bessemer and open-hearth steel indicate very emphatically the superiority of the latter kind of steel. The amount of discard or cropping of the ingot (to remove spongy or defective metal) has been a matter of considerable controversy between railway engineers and rail manufacturers, and steps have been taken to determine the respective qualities of rails for different parts of the ingot. On this point the committee remarks as follows:

> The marking of the rails to distinguish the position in the ingot has become very general, and the reports were much more complete than ever before. The failures of (A) rails [from the head of the ingot] are the most numerous, but there are also very many failures of (B) and (C) rails and no inconsiderable number of (D) and (E), while there are occasional ones even lower down.
>
> Unless there is an improvement in the making of the ingots, it will require the elimination entirely of the (A), (B) and (C) rails, to be sure of having only sound ones in the track. As this would mean a great waste of material, with resultant loss of economy, it emphasizes the necessity for continued study of rail manufacture in order to obtain rails as nearly faultless as possible, without extravagance.

Particular attention has been given to the question of producing special grades of steel (and notably alloy steels) for rails that will give good service under modern conditions of heavy loads and heavy traffic. We give below some extracts from the part of the committee's statement which relates to the results of such rails in actual service for experimental purposes.

Comparative Wear of Special and Alloy Rails.

Several companies are making trials of experimental lots of both special Bessemer and open-hearth steel, and with different alloys, such as ferro-titanium, nickel, chromium-nickel, etc., but in some instances the results have not been very satisfactory. The average number of failures per 10,000 tons of rail laid for the different kinds tested are as follows: Open-hearth steel with ferro-titanium, 12; Bessemer steel with ferro-titanium, 13⅓; Bessemer steel with nickel, 96; open-hearth steel with chromium-nickel, 640.

FERRO-TITANIUM TREATMENT.—The record for failures is bad on the Central R. R. of New Jersey, being 1,019 per 10,000 tons of rail, but the quantity tested is very small (373 tons). This is 90-lb. rail with carbon 0.45 to 0.55, phosphorus 0.10, manganese 0.84 to 0.114, silicon 0.20, and ferro-titanium 0.3. Other lots of the rail have made a better showing. The failures are thought to be due to imperfect rolling and not to the ferro-titanium.

On the Baltimore & Ohio R. R. 90-lb. Bessemer rail with ferro-titanium is being compared with open-hearth rail on Kessler's Curve. The percentage of area of head abraded was 3.8 and 4.4 for ferro-titanium and 4.2 for open-hearth in four months. Also 100-lb. Bessemer steel with ferro-titanium was compared with ordinary Bessemer steel on the same curve, and in 22 months the percentage of area of head abraded was 9.5 for ferro-titanium and 17.7 for Bessemer. This Bessemer rail was worn out and replaced by Bessemer, which wore 6.4% in less than six months.

On the Lake Shore & Michigan Southern Ry., 100-lb. steel with ferro-titanium is being compared with ordinary Bessemer rail. In some of these tests not much superiority is shown for the ferro-titanium, while in others there is considerable. On the New York Central R. R., 80-lb. rail with metallic titanium 0.033 is being compared with 80-lb. ordinary Bessemer, the record for 18 months showing less wear for the ordinary Bessemer than for the ferro-titanium, although the difference is but slight.

It will be observed that up to the present time the results are conflicting, the one good test on the Baltimore & Ohio R. R. perhaps being due to the higher carbon, while the other tests, where the results are about the same, are with the usual carbon for that quality of steel. The large number of failures on the Central R. R. of New Jersey, mostly broken base, is rather alarming and discouraging.

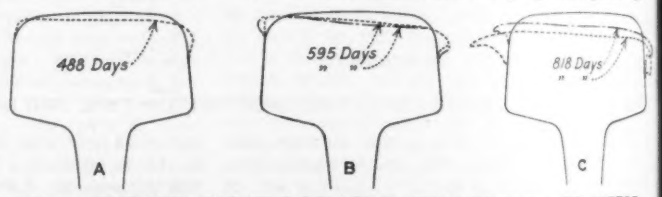

FIG. 2. SECTIONS SHOWING RELATIVE WEAR OF RAILS OF DIFFERENT GRADES OF STEEL ON A 6 DEGREE CURVE (INNER OR LOW RAIL); PENNSYLVANIA R. R.

STEEL WITH CHROMIUM-NICKEL.—The record for 90-lb. Am. Soc. C. E. open-hearth rail with chromium and nickel on the Central R. R. of New Jersey has been very bad so far as failures are concerned, there having been 1,129 per 10,000 tons of rail laid, mostly breakages. Small lots have also been tested on the B. & O. R. R. and the Erie R. R., with a large number of failures. That on the B. & O. is 90-lb. rail, with 595 failures per 10,000 tons; and that on the Erie is 90-lb. rail with 289 failures per 10,000 tons. The amount of nickel is 2 to 2½%, and the chromium 0.5 to 0.9%. In the case of the B. & O. the carbon is rather low for open-hearth steel, while on the Erie it is more nearly the usual amount.

A small lot on the New York, Ontario & Western Ry. has given better results, and also a larger amount on the Lehigh Valley R. R., although the number of failures, especially breakages, is very considerable.

The Baltimore & Ohio is comparing 90-lb. steel, containing nickel and chromium, with ordinary open-hearth rail on curves ranging from 4½ to 9½°. The results are variable, in one case the chrome-nickel showing a greater percentage of wear than the open-hearth, while in other cases the open-hearth shows 50% greater wear than chrome-nickel, the duration of time being one and one-half years. It is difficult to understand the difference, as the respective kinds of material are the same in each case.

When compared with ordinary Bessemer rail, the per cent. of area of head abraded was from 2½ to 3 times as much for the Bessemer rail as for the chromium-nickel rail. In the Lehigh Valley tests, 90-lb. steel, with nickel and chromium, was compared with ordinary open-hearth rail and the percentage of area of head abraded in four to 8 to 18 months was 70% greater in the case of the open-hearth than of the chrome-nickel.

A test is being conducted by the Pennsylvania Lines of 85-lb. open-hearth rails of Mayari ore from Cuba, and in ten months ordinary Bessemer steel shows twice the wear. The chemical composition is: Carbon 0.805, phosphorus 0.022, manganese 0.87, silicon 0.17, sulphur 0.035, nickel 0.37 and chromium 0.21. It will be noted that it is a chromium-nickel rail, but of very different composition from the tests cited above.

MANGANESE STEEL.—The Norfolk & Western R. R. is comparing 85-lb. manganese steel with ordinary Bessemer, and up to the present time the percentage of area of head abraded is a trifle over three times as much for the Bessemer as for the manganese. The composition of the manganese rail is: Carbon 0.77, phosphorus 0.06, manganese 9.93, silicon 0.25, sulphur 0.028, and the test has lasted for 19 months. On the Lake Shore & Michigan Southern Ry., 85-lb. manganese rail is being compared with ferro-titanium steel, and in eight months the ferro-titanium shows a little more than twice as much wear as the manganese.

MISCELLANEOUS.—The Baltimore & Ohio R. R. compared the wear of 90-lb. open-hearth rail with Bessemer rail on a curve of 7° 5', and in one year the percentage of area of head abraded was 9.8 for the open-hearth and 26.9 for the Bessemer. The Lake Shore & Michigan Southern Ry. compared 80-lb. rail made by the electric process with ordinary Bessemer rail, with the result that in eight months but little difference between them was shown. The New York Central R. R. compared basic open-hearth rail of 100-lb. Dudley section, with ordinary Bessemer rail, same section, with but little difference in the comparative wear in 1½ years.

Ordinary Steel Versus Special Steel for Rails.

The Pennsylvania Railroad has been making some interesting service trials as to the comparative wear of different grades of steel, and some of the results are shown very clearly in the sections in Figs. 1 and 2. The rails in question were on the high and low side respectively of a 6° curve in main track carrying both passenger and freight traffic. These sections are reproduced from among a larger number given in the bulletin mentioned above, and presented by Mr. Jos. T. Richards, M. Am. Soc. C. E., Chief Engineer of Maintenance of Way of the the Pennsylvania Railroad (and a member of the Rail Committee already referred to).

In a statement accompanying the drawings, Mr. Richards expresses the opinion that more attention should be paid to getting rails of good quality made under present specifications, rather than seeking to obtain special grades of steel for rails subjected to severe conditions of service. We give below an abstract of the statement setting forth his views in this respect:

> I am impressed that we are doing a great deal of work, but along the line which may be called experimental; we are to a degree hunting something new in the composition of rail, like chromium and nickel. I believe our committee should turn its attention to perfecting the rail as we know it under the present well worked out analyses and specifications, because a good rail can be made under our specifications and well-known composition, if the mill practice is right.

*Bulletin No. 137 (July, 1911); American Railway Engineering Association, 962 Monadnock Block, Chicago.

SERVICE OF RAILS OF SPECIAL OPEN-HEARTH STEEL WITH LOW PHOSPHORUS AND LARGE DISCARD (Rolled in 1908)

Railway.	A. T. & S. F.	B. & O.	C. B. & Q.	C. of N. J.	D. & H.	D. L. & W.	Erie	Long Island	Lehigh Valley.	Union Pacific
Tons Laid.	16,846	1,000	10,000	5,502	1,000	....	1,000	900	....	5,000
Wt. per yd.	....	90 lbs.	....	90 lbs.	90 lbs.	....	90 lbs.	100 lbs.	....	75 lbs.
Section.	....	A. R. A. (B.)	....	A. S. C. E.	A. S. C. E.	A. S. C. E.	A. S. C. E.	A. S. C. E.	....	C. S.
Analysis: Car.	0.60 to 0.70	0.65 to 0.75	0.55 to 0.67	0.64 to 0.64	0.57 to 0.67	0.67 to 0.80	0.54 to 0.64	0.70 to 0.78	....	....
Man.	0.70 to 1.00	0.75 to 1.00	0.70 to 1.00	0.82 to 0.82	0.70 to 1.00	0.80 to 1.05	0.70 to 1.00	0.71 to 0.80	.... 0.03	....
Phos.	Not over 0.04	Not over 0.06	0.04 to 0.045	Not over 0.03	Not over 0.04	Not over 0.04	Not over 0.06	0.02 to 0.03	Not over 0.04	....
Sil.	Not over 0.20	0.10 to 0.20	....	....	Not over 0.20	Not over 0.02	Not over 0.20	.04 to .06	....	....
Sul.	Not over 0.06	....	....	....	....	Not over 0.06	....	....	....	....
Discard	9%	9%	....	9%	15%	15% & 20%	9%	9%	20%	31.7%
Wear	....	Exceptionally good	Good	No better than Bessemer	....	....	....	Not appreciable.	Excellent	No better than ordinary O.-H. rail
Failures	7 per 10,000 tons laid	More than other O. H. rail	Numerous	....	None	....	....	....	....	....
Price	$31	....	$34.50	No increase	$33	$33 & $35	$30	....	....	....
Justified	....	Yes	No	....	Yes	No	Problematical	....	....	No

B. & O. R. R.—Have recommended open-hearth exclusively for 1911. 9% discard at $3 per ton additional is the most economical.

C. R. R. of N. J.—Rails proved soft and mushy, and carbon was made 0.65 to 0.75% with much better results.

D. & H. R. R.—Also laid 1,000 tons of rails with carbon 0.55 to 0.65% and phosphorus 0.05%, and 100 tons with carbon 0.54 to 0.64% and phosphorus 0.04%, with same resuts as above

D., L. & W. R. R.—Are having plain open-hearth rails rolled this year.

Lehigh Valley R. R.—Now using 0.1% titanium, 0.82% carbon, 0.04% phosphorus, 15% discard. Would not pay premium for phosphorus below 0.04%.

Union Pacific R. R.—Seven rails rolled from each ingot, the lower five classed as "premium" rails.

Experimenting outside of this line is only beating around the bush, whereas, to get the rail we are seeking requires prompt action in the direction above outlined. I am firmly convinced that the mills can make a good rail. We all know very well what the mill practice did in making the old "John Brown" and "Charles Cammel" rail more than 40 years ago at the crude mills and under the imperfect specifications of that time.

We have had open-hearth rails made by the mills and tested under heavy tonnage on our main line near Union Furnace, Middle Division, on a 6° curve in the eastbound track; carrying both passenger and freight trains. The analyses of these rails are shown on the accompanying diagrams [some of these only are shown in Fig. 1. Ed.], and on these are marked also the wear and life of the rail.

It will be observed that the carbon was high and the phosphorus low. The comparison of the two open-hearth steels was carbon 0.79% with phosphorus 0.024%, and carbon 0.896%, with phosphorus 0.009%. As we are developing the open-hearth rail I would call special attention to it in this test. The Bessemer rail was worn out and removed from track after service of 405 days, so that it is not shown in the following measurements, No. 4 to No. 8. As to the nickel rail and the high-carbon, open-hearth rails, the last measurement was taken after being in use 818 days. This high-carbon rail did not fail or break during the test, and was not nearly as much worn in 818 days as the Bessemer was in 405 days.

This shows the value and economy in using the high-carbon open-hearth rail. In asking the mills to reproduce this rail we have met with some success, although in some cases they have failed to give us rail that will come up to this test in durability. The Bessemer process might well be eliminated, for the reason that ore suitable for Bessemer steel has practically disappeared, and the mills have largely been rebuilt for the open-hearth process. We are marking time when we pay too much attention to the Bessemer process.

In the long line that we are following in rail making I will give another statement (see the accompanying table) to show the results from open-hearth rails made in 1907 under specifications prepared jointly by the mill men and railway men. It is rather surprising to see this following about two years after our trial of 1905, in which an open-hearth rail was found to last so well and not break in track. I think the poor results shown in this table are largely due to the fact that these rails have been too low in carbon and consequently too soft. It has turned out so badly that some of the railways have reported to me that this rail is no better than Bessemer rail. Yet it will be noted that the railways have paid $31 to $35 per ton for this rail, when the ordinary rail was selling at $28 per ton.

It is a well-known principle that as the phosphorus is decreased carbon should be increased. It can safely be done, and will give us a rail that will wear longer and not break.

As to the titanium and chrome-nickel rail, that is, experimenting with these new elements, I see no objection whatever. It is all proper in its way as a side issue. But it is slow, and should in no way hold back our perfecting the open-hearth rail, as we know it from mill practice and specifications.

Machinery and Equipment of the U. S. Battleship "Utah."

The new United States Battleship "Utah," with a displacement of 21,825 tons, is now the largest of the Navy, although there are two larger vessels—the "Arkansas" and the "Wyoming," 26,000 tons—under construction, and two others still larger (27,000 tons) have been authorized. The "Utah's keel was laid Feb. 22, 1909. Her hull was launched Dec. 23 of the same year and the official trials were made June 26 to July 2, 1911. The "Utah" was not delivered to the Government, however, until September. Her sister ship, the "Florida," is now nearing completion in the New York Navy Yard. The "Utah" has a length between perpendiculars of 510 ft. Her extreme breadth at L. W. L., outside the armor is about 88¼ ft. and her molded depth is 44½ ft. The block coefficient of fineness of her hull is .5837. The length of the fire-room space is 102 ft., and that of the engine-room space 60 ft.

The following description of the "Utah's" machinery and equipment is based on information given in an article by Lieut.-Commander William Russell White, U. S. N., published in the August "Journal" of the American Society of Naval Engineers.

Propelling Machinery.

The ship's propelling machinery consists of ten Parsons turbines, six for going ahead and four for going astern. The ahead turbines developed on the official trials a total of 29,000 HP., giving the vessel a maximum speed of about 21 knots, which was somewhat in excess of the contract requirement. The turbines are mounted on four propeller shafts and are arranged for use in four different combinations—for full speed ahead, high cruising speed, low cruising speed and going astern. For the low cruising speed a quadruple-expansion arrangement is used, the steam passing successively through the high-pressure cruising turbine, the intermediate-pressure cruising turbine, the main high-pressure turbines and the main low-pressure turbines. For high cruising speed, the high-pressure cruising turbine is cut out, giving a triple-expansion arrangement. For full speed, only the main high and low-pressure turbines are used. The total water consumption for turbines and auxiliaries per shaft horsepower of the main turbines was 25 lbs. per hour at 12 knots, 15.3 lbs. at 19 knots and 15 lbs. at full speed.

The diameter of the line shafts is 12⅛ ins. with an axial hole 8 ins. in diameter. The propeller shafts have an outside diameter of 12⅜ ins. with a 7¼-in. hole. Each propeller shaft is supported by a single strut bearing fitted with lignum vitae. A Foettinger torsion meter is installed on each shaft for determining the shaft horsepower of the main turbines. The four propellers are all the same size and are solid castings of manganese bronze, with three blades. They all turn outboard for the ahead motion. The propeller diameter is 9 ft. 2 ins. and the pitch is 8 ft. 6⅛ ins. They are mounted so that the lower blade tips are about 3½ ft. above the keel.

The boilers are of the Babcock & Wilcox type and are arranged for both coal and oil firing. They were designed, built and installed by that boiler company. There are twelve boilers, placed four each in three water-tight compartments. Each boiler is provided with five furnace doors and is fitted with eight flat-spray fuel-oil burners. These burners, with a pressure of 200 lbs. per sq. in., will atomize from 145 to 300 lbs. of heated fuel oil per hour. The oil-firing system, however, is intended to be kept in reserve for emergencies, and coal firing is to be used under ordinary conditions. The fuel oil is carried in double bottoms under the engine-rooms, from where it is driven by pumps to two cylindrical settling tanks, each of 3,750 gals. capacity, in which are steam heating coils. From the settling tanks the oil is pumped through steam heaters of the corrugated-film type and through high-pressure strainers to the burners.

All steam pipes above 2 ins. in diameter are of seamless drawn-steel tubing, with rolled steel flanges, designed for a working pressure of 210 lbs. per sq. in. The expansion of the main steam pipes, which are from 7½ to 14 ins. in diameter, is taken care of by expansion joints in each compartment. Where pipes are bolted to athwartship bulkheads, allowance for expansion is made by means of oval bolt holes. The piping is lagged with sectional magnesia covering, with canvas sewed on and well painted and with an outer covering of galvanized sheet iron.

Fire Room Equipment.

An interesting feature of the fire-room is an electrical timing device to aid in the systematic firing of the boilers. The device can be regulated for any desired period of firing. At the set intervals it causes a gong to be sounded and numbers to be flashed on suitable indicators placed on each side of each fire-room to show when each furnace is to be fired or worked.

On a level with the upper platform deck in each fire-room are mounted four electrically-driven, forced-draft blowers. Multivane fans 30 ins. in diameter are used. They are located in pairs on each side of the ship in air-tight compartments and are supplied with air from uptakes immediately above, delivering directly into the top of the fire-rooms. Their speed on the

full-power trial averaged 621 r. p. m., the total horsepower for all four blowers being 220.

The ash-handling equipment includes both ash hoists and ash ejectors. The bucket guide rails of the ash hoists extend from the bottom of the ventilation trunk to a point well above the main deck, but no trolleys are provided for taking ashes from the ventilators to the ship's side. Under tests with 100 lbs. steam pressure, a 300-lb. load of ashes was hoisted from the fire-room floor to the upper deck in seven seconds. The hoisting engines are of the reciprocating type with a rope drum. Three separate hoists are provided.

In each fire-room there is an independent ash ejector system. The ash-discharge pipe leads upwards from the hoppers at the sides of the fire-room and overboard through the armor above the water line with but one bend. Each pair of hoppers is served by a steam-driven pump 12 × 7 × 12 ins.

Water Supply System.

The water-supply system includes fire pumps, pumps for sanitary and flushing purposes and a distilling plant. There are four fire pumps, which also serve as bilge pumps, located one in each fire-room on the amidships line. The pumps are of the vertical-piston, double-acting single type, 12 × 10 × 18 ins. These pumps have no fresh water suctions. The fire main, which is a steel lead-lined pipe, extends along each side of the ship through the engine-rooms, steam-pipe passage and fire-rooms under the protective deck. Six-inch flooding valves and piping are provided for the coal bunkers. A branch from the fire main supplies salt water for the bath-rooms of the admiral, captain and some of the other officers. Another branch supplies the firemen's wash-rooms and the crew's and officers' galleys. The fire main is equipped with relief valves set at 100 lbs., from which discharge lines lead overboard by way of the scuppers.

Two separate flushing systems are provided; one forward and one aft. The forward system is supplied with water from the fire and bilge pumps. It consists of steel lead-lined piping leading to the forward ice machine, the ward-room, bath-rooms, dish-washing rooms, laundry, etc. The aft system is supplied by two electrically-driven centrifugal pumps with a 5-in. discharge pipe leading up to the crew's toilet and wash-rooms on the gun deck. All drain-pipes from baths, wash-rooms, pantries and galleys lead overboard directly by the shortest route.

The evaporating and distilling plant is on the berth deck just forward of the engine-room hatches, and consists of four evaporators and four distillers with a designed total capacity of 25,000 gals. of potable water per 24 hours, when running in single effect. For purposes of economy, the plant is also piped so that it can be run in double effect. Each evaporator has 108 brass tubes 1½ ins. in diameter and 6 ft. long, the total heating surface being 312 sq. ft. The distillers are of the corrugated-film type.

From the distiller pumps the fresh water is discharged into tanks in the forward hold, and from these tanks it is raised by two electrically-driven pumps to gravity tanks located at a level above that of the admiral's cabin. From the gravity tanks water flows to all officers' bath-rooms, to the galleys, bakery, wash-rooms, laundry, sick bay, etc. In case the gravity tanks are out of order, all parts of the ship may be supplied by an electric pump.

A separate flooding system is provided for each of the three groups of magazines. The magazines on the lower platform deck are flooded by means of sea connections, while the upper platform magazines are flooded or sprinkled by water from the fire main. All magazine flood valves are gate valves operated from the berth deck. The sprinkling system consists of 2½-in. brass piping perforated on the under side and arranged so that any powder tank can be sprinkled separately.

Heating, Ventilation and Refrigeration.

The heating, ventilating and cooling system includes a plant for supplying artificially cooled air to the main magazines. Separate equipment is provided for each of the three magazines, to each of which air is supplied by a blower having a capacity of about 2,000 cu. ft. per min. The temperature of the air is reduced in a corrugated-film cooler, in which the cooling medium is compressed air from one of the Allen dense-air ice machines. The coolers for the forward and aft magazines have three units each and the amidship's cooler has two units. The cooling capacity per unit is 800 cu. ft. of air per min. reduced from 70° to 50° F. The magazines are lagged where necessary to prevent the conduction of heat.

The refrigerating plant for cold storage is located on the starboard berth deck over the engine-room. There are five refrigerating-rooms separated by air locks and insulated with cork, with a zinc lining. The doors are covered with sheet lead. These storage-rooms are cooled by four ice machines of the dense-air type, each designed for a cooling effect equivalent to three tons of ice in 24 hours. Connections are fitted to the air-compressor lines to build up pressure quickly in the ice machines.

Artificial ventilation has been provided where necessary for all quarters, living spaces, passages, store-rooms and magazines. There are 32 motor-driven ventilating fans each on its own circuit for supplying air on the plenum system to the different compartments. The air is supplied by the fans at a pressure of from 4 to 9 lbs. per sq. ft. and at a velocity of from 1,200 to 7,000 ft. per min. in the different compartments. None of the principal water-tight bulkheads of the ship have been pierced by ventilating ducts and no ducts have been carried through the transverse slopes of the protective deck. Some of the ducts are carried through the flat portion and the fore and aft slopes of the protective deck, but these are made practically water-tight above the berth deck. All ducts passing through the magazines are of galvanized seamless-steel tubing, or are built up of heavy-gage steel, worked water-tight.

A new departure in navy practice in connection with the ventilation of the living quarters is the use of indirect steam coils in the air-supply line to supplement the direct radiator coils in the quarters. The direct radiators are made up from 1-in. seamless-drawn brass pipe of iron-pipe size with composition fittings. The indirect radiators are installed in tanks or boxes fitted between the deck beams on the berth and gun decks. These boxes receive air from the ventilating fans and pass it through the steam-filled coils on its way to the living spaces. The coils are made up of 1-in. seamless-drawn brass pipe. Dampers are arranged for by-passing the air in warm weather.

All steam lines to the heating systems are fitted with relief valves set at 30 lbs. per sq. in. The steam and drain-pipes consist of seamless-drawn brass pipe, of iron-pipe size. All the pipes up to 1½ ins. in diameter are connected by composition fittings, but above that size by composition flanges. Connections at water-tight bulkheads are made with composition stuffing boxes, and U-bends are provided to compensate expansion in the pipe lines.

The air-compressor plant is placed on the center-line bulkheads above the grating in the engine-rooms. Nine 11 × 11 × 12-in. steam-driven compressors are provided having a combined capacity of 360 cu. ft. of free air per min. at 150 lbs. pressure. A working pressure of 100 lbs. per sq. in. is maintained by automatic governors. The compressors discharge into four air reservoirs with a capacity of about 45,000 cu. ins. each. Air is supplied from the reservoirs to the pneumatic-tool connections in the engine-rooms, to the workshop, to the soot blowers and pneumatic-tool connections in the fire-rooms and to the gas ejector system for removing smoke from the turret guns and the 5-in. rapid-fire guns.

A 1,200-KW. electric generating plant is installed under the protective deck just forward of the fire-rooms, and supplies current for both power and lighting purposes. There are four 300-KW. turbo-generators of the six-pole compound-wound type, each with a full-load capacity of 2,400 amps. at 125 volts, with a speed of 1,500 r. p. m. They are driven by two-stage Curtis turbines with three rows of moving buckets in each stage. The lighting system comprises a total of about 2,000 lighting fixtures, not including special outlets for signal lanterns, etc. Two mercury-vapor lights are provided in each engine-room and fire-room, and there are 16 36-in. searchlights variously disposed on the superstructure, masts and crane towers. A complete system of wireless telegraphy is also installed.

The wiring for the power system is quite separate and distinct from the lighting system. It supplies energy to all auxiliary machinery run by electric motors, including a clothes-washing machine, mangle, ironer and wringer in the laundry; a potato-peeler, dough-mixer, meat-chopper, ice-cream freezer and dish-washing machine in the kitchen; various motor-driven pumps, blowers and hoists, ammunition conveyors, air compressors for torpedos, and to the turret training motors.

Repair Shops.

The machine-shop is located amidship on the berth deck between the two engine-room hatches, and can be reached from the gun deck through the port engine-room hatch. The machine tools are driven by independent enclosed electric motors. The tools installed include a 28 × 46-in. x 10-ft. extension gap lathe and two smaller lathes. There is a tool-room shaper, a 28-in. upright drill and a 16-in. sensitive drill, beside a universal milling machine and a portable cylinder-boring machine.

A steel blacksmith's forge is provided with necessary tools and fixtures, including a 140-lb. anvil. The blacksmith shop is on the main deck abaft No. 3 turret. Space is provided for the ship's foundry and coppersmith shop.

Two Novelties in Drafting Compasses are a parallel-motion device for keeping the handle central, and a more elaborate device of the same nature for keeping the compass legs strictly parallel at all openings. The former consists of a small pair of parallelogram links near the upper end of the compass legs, whose pin engages a slot in a downward extension of the handle; the arrangement is simple and unobtrusive and does not change the size or shape of the tool. The other device involves a complete change of construction of the compass. Two long pairs of parallel-motion links take the place of the upper halves of the compass legs. The junction plate at the top has the handle directly attached. The lower end of either parallelogram is formed by a short bar with a socket for the removable compass leg. These sockets are parallel to the handle. A short straight compass-leg section may be inserted, or for large circles a Z-shaped piece extending out horizontally and carrying the pivot point, pencil, or pen, at its outer end. This new form of compass is made by J. Halden & Co., Ltd. of Manchester, England.

In Connection With the Austin Dam Failure, the rainfall figures for the region are interesting. The U. S. Weather Bureau has a record of 20 years' observation at Emporium, Cameron County, Pa., which is 12 mi. from Austin. Mr. T. B. Lloyd, of Emporium, is Cooperative Observer of the Weather Bureau. The average annual rainfall for the 20 years, 1889-1908, was 43.95 ins. Both 1909 and 1910 were fully 5 ins. below this average, and the first half of 1911 was even dryer. August and September, however, brought very heavy rainfalls, the total for the two months (13.59 ins.) being greater than the corresponding total in any year since 1890 (15.67 ins.); but 1890 was abnormal, having a year's total of 62.26, against an average of 43.95 ins. The following table gives the 20-year mean, and the figures for 1909, 1910 and 1911:

RAINFALL AT EMPORIUM, CAMDEN CO., PA.

	20-yr. Mean, 1889-1908.	1909.	1910.	1911.
January	3.23	2.88	6.50	4.32
February	2.98	5.73	4.11	3.27
March	3.98	2.79	0.59	2.94
April	3.13	6.73	5.14	3.41
May	4.65	3.59	2.04	1.95
June	4.47	5.75	2.21	4.15
July	4.92	1.95	3.42	1.64
August	3.70	0.86	1.97	7.45
September	3.38	1.98	5.00	6.14
October	3.10	2.14	1.54	...
November	2.88	1.50	2.40	...
December	3.53	2.45	3.61	...
Year	43.95	38.45	38.53	....

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A Technical Journal Should Not be an "Organ."

Studies of accidents which occur to engineering works may be either used or misused. The use of such studies is to find, after ascertainment of the facts, what practical lessons may be drawn from the accident for the guidance of designers and constructors.

The misuse of such accidents consists in exploiting them for commercial purposes. Not seldom the circumstances are distorted and misrepresented in order to injure the reputation of a competitor. It is not at all uncommon for enterprising (?) business concerns to circulate printed matter, often a reprint from a sensational newspaper story, concerning an accident to injure some competitor. This sort of competition, however, is apt to react upon the "enterprising" concern which undertakes it. It is pretty well recognized in business circles that the man who "knocks" a competitor does not generally help his own business.

Another too common misuse of engineering accidents is found in some of the technical publications which are devoted to a single industry. Such journals too often seem to regard it as their proper function to twist matter into such shape as will most injure competing industries and yield most benefit to the one they represent.

In a recent issue of a journal devoted to the stone industry appears an article on the Austin dam failure with the lurid title "The Menace of Concrete." The article itself is likewise lurid, for the editor remarks: "A great concrete dam has crumbled as if it were mud. * * * There is not a concrete dam, bridge or large building that is not of daily menace to life * * * There are facts damning to all concrete work from which it is impossible to escape."

Unfortunately for this journal's reputation among its readers, the photograph which it prints of the wrecked Austin dam, like the photographs reproduced in Engineering News of Oct. 12, shows that the concrete of the dam withstood the flood in really remarkable shape. The dam failed, as everybody now knows, by sliding on its foundation, and it would have slid just as surely and certainly if it had been built of cut stone.

Furthermore, the contrast is noticeable between the condition in which the flood left this concrete dam, with huge sections practically intact and the condition of the ruins of certain rubble masonry dams which failed in the South in 1901 and were thoroughly disintegrated by the floods which destroyed them.

That the real object of this journal devoted to the stone industry was not to present the facts and the lessons of the Austin dam disaster, but to misuse the occurrence to "knock" concrete as a competitor of stone is made still more evident by other articles in the same issue. In one, for instance, extracts from recent discussions concerning electrolysis of steel in reinforced concrete which have been published in Engineering News are presented in such a way as to cast a slur on reinforced-concrete construction.

We call attention to this matter, not because we believe any notable injury is done to the concrete industry by such transparent attempts to "knock" it. The use of concrete for ten thousand different purposes is now so firmly established that the editor who would attempt to combat its use has as hopeless a task as the famous dame who attempted to sweep back the Atlantic Ocean with a broom. What is really important is the debasing of technical journalism by making it a vehicle to serve this or that or the other special interest by distortion of facts, or by the presentation of narrow and prejudiced views.

The technical journal has come to play so important a part in the industrial and commercial life of the present day that it cannot afford to follow the methods of partisan politics. A journal best serves its readers and best serves the industry it represents when it presents the truth and when it treats all subjects from a broad and impartial point of view.

What Is the Frictional Resistance in Pounds Per Ton to an Aeroplane's Motion?

The number of inventors who are at work on improvements to the aeroplane and the interest incited in the public mind by the feats of flying, which are now a common feature of amusement parks all over the country, are likely to lead many to overlook the limitations which exist in the aeroplane as a vehicle for commerical use. It is true that the great number of fatalities to aviators has given the public an inkling as to the inherent danger inseparable from machines for navigating the air, but it is common to hear it said that these dangers will largely be overcome by the work of inventors and designers.

There is another aspect from which the limitations of the aeroplane are to be viewed, however, and it is presented in a unique way in an editorial which we find in a recent number of "The Engineer," London. We quote the following paragraphs:

At present any use of the aeroplane for other than military service seems to be almost exclusively of a sporting character. It is often spoken of unthinkingly as a carrier of passengers and goods, but a little consideration will show how unlikely any such development really is.

The gliding angle of a good aeroplane may be put down as 1 to 6, corresponding to a resistance against its motion of rather over 370 lbs. per ton. Now let this be compared with the resistance that has to be overcome in other modes of transport of passengers and goods. By railway transit the resistance is brought down as low as 10 lbs. to 20 lbs. per ton, depending on the speed, or about 95% less than the resistance through the air. On steamships the resistance is even lower, sometimes as low as 1 lb. per ton, so that the effort to propel 370 tons by water would be no more than that required to propel 1 ton through the air on an aeroplane. These figures are worth bearing in mind when the future progress of aerial navigation is being considered.

It may be said by way of criticism of this rough-and-ready criterion that the same argument would show the futility of road motor transport, as the resistance to be overcome is there some 70 lbs. per ton, or at least five times what it would be on a railway at about the same speed. The answer is, of course, that road motor transport is uneconomical when run side by side with a railway, and it is only of practical use when employed in a subsidiary capacity as a railway feeder from districts where there are no railway facilities or where special circumstances mask the ordinary conditions of competition between the two. Moreover, it must be granted that there are other items of cost beyond those which depend directly on the resistance, and therefore, for a given speed, on the horsepower required.

But the enormous difference between the 370 lbs. per ton of aerial transport and the 70 lbs. per ton of road transport make it almost impossible, except in the most special circumstances, such as absence of roads, rails, and waterways that such a means of transport can be economically possible. It is convenient to remember that to transport a ton of goods by aeroplane needs about the same engine effort as it would to drag it along the ground without wheels at all.

The reasoning of our contemporary will be readily followed by engineers accustomed to computing the resistance to motion of railway trains on grades. It may, at first sight, appear strange that a machine which neither rolls on the land nor plows through the water, but skims through the air like a bird, should have a greater frictional resistance by far than any vehicle moving on either water or land. The reason is evident, however, in the great amount of skin friction of a body moving through the air at high speed and presenting an enormous surface in proportion to its weight. When this is taken into account, and when we add to it the consideration that the total load carried can be only a small percentage of the weight of the machine with its necessary propelling mechanism, it is evident what a great handicap the aeroplane is under for any form of commercial transport, even were the problem of safety solved.

The French Search for Water Sterilizing Processes.

For many years past French engineers and sanitarians have been on the quest for some method of treating public water-supplies which should remove from the water the very last germ it contained or should at least reduce bacteria to such a small number that the few remaining would die of lonesomeness. Various processes designed to achieve this counsel of perfection have been tested from time to time by the city of Paris or the companies which supply its suburbs. Now comes the city of Marseilles with reports of a test of eight different small-scale sterilizing installations, designed to aid in selection of a method of water purification to deal with a daily supply of 36,000,000 gals. or more. An abstract of a report on these tests appears elsewhere in this issue.

The processes tested included several systems of multiple filtration; filtration combined with (a) ultra-violet and (b) ozone; and coagulation and sedimentation, with and without disinfection. Broadly speaking, the tests turned out, bacterially, about as might have been expected in view of previous experience with the various methods and combinations of water treatment under test.

Had figures of comparative cost been given, the results of the tests might be of some practical value—if for no other purpose than to show the financial impracticability of some of the schemes tried, and the high cost of corraling the last few bacteria. This cost seems to be far in excess of the sanitary benefit that it would give.

The view generally taken by American and English sanitarians of water sterilizing processes in general has long been the practical one that it is best to bring the efficiency of other branches of municipal sanitation somewhere near 99% before trying to raise the bacterial efficiency of the well-known systems of water purification from 99+ to 100%. The cost of removing the last score or so of bacteria from each cubic centimeter of water, representing perhaps 0.1% or less of the original bacterial contents and mostly harmless at that, is likely to amount to much more than enough to accomplish far-reaching sanitary reforms in other fields of municipal activity.

The Government's Suit Against the United States Steel Corporation.

The filing of the Government's suit for the dissolution of the United States Steel Corporation last week has aroused public interest throughout the country, and indeed throughout the world, to a greater extent than any other proceeding ever undertaken under the Anti-trust Act. There is so much current misconception and current misstatement afloat at the present time concerning the Sherman law that it seems worth while to briefly summarize here the main facts regarding it.

The so-called Sherman Act became a law on July 2, 1890. It was enacted by Congress in response to an overwhelming public demand for legislation to stop the rapid growth of all sorts of combinations for the restriction of competition. The five or ten years prior to the passage of the Sherman Act had been a period of great activity in the formation of trade associations in various industries designed to limit competition and also in the development of trusts, modeled in their general arrangement on the lines of the Standard Oil Trust.

The Sherman Act, while it bears the name of the eminent Ohio Senator, was actually framed by Senator George F. Edmunds, of Vermont, universally recognized as one of the ablest lawyers and legislators of that day. It was not, as has been frequently claimed, the work of demagogues, but was carefully drawn by high legal authority to protect the public against the growing power of monopoly. The essence of the Sherman Act is contained in its first clause, which reads as follows:

> Every contract, combination, in the form of trust or otherwise, or conspiracy in restraint of trade or commerce among the several states or with foreign nations, is hereby declared to be illegal.

The words "restraint of trade or commerce" used in the Act have a definite significance in law and refer specifically to the restraint of trade through the limitation of competition in buying or selling by any means whatever.

That the Sherman Act is constitutional has never been very seriously questioned, and when the issue was raised in one important case its constitutionality was affirmed by the United States Supreme Court.

It was extremely unfortunate, every one will now admit, that the first important case brought under the Sherman Act—the so-called Sugar Trust case, which was passed upon by the Supreme Court in 1894—was decided adversely to the Government. The decision was based on the very narrow ground that in the particular case in question the combination related to manufacture only, and that manufacture was not commerce. Against this view of the majority of the Court, a vigorous dissenting opinion was filed by the late Justice Harlan.

The business public of that day, however, and even the legal profession, to a considerable extent, acquired a wrong impression from the Sugar Trust decision. It came to be generally believed that the Sherman Act would be narrowly construed by the courts so that it need not be considered as a serious obstacle to the formation of consolidations in business or of trade associations to limit competition. More than that, there was widely prevalent at that day an impression that the influence in Governmental affairs of what has come to be known as "Big Business" was such that the Sherman law would never be seriously enforced.

That the Sherman law really had teeth, however, was made evident as early as 1899, in the Addyston Pipe case, the original decision in which was made by President Taft when a Federal Judge and was sustained both by the Court of Appeals and the Supreme Court. In this case, however, the limitation of competition by an association of cast-iron pipe manufacturers was so clear and so aggravated, that there was no room for doubt as to the actual injury to the public and the infringement of the law.

At the close of the decade ending in 1900, there was a general belief among business men, bankers and even among lawyers that while combinations of independent concerns to limit their prices or to submit their operations to the control of a board of trustees was doubtless contrary to the Sherman law, there was nothing in that law to prevent the actual consolidation of competing concerns.

Further than this, so little had been done by the Government in bringing and forwarding suits under the law that it was quite generally considered a dead letter not necessary to take into account in the conduct of business.

The lull in the formation of combinations in the years from 1890 to 1897 was due, probably, as much to the business depression which prevailed as to fear of the Sherman law. At any rate, so little had been done to make the law effective in the seven or eight years following its passage that with the business revival which began in 1898 there began a perfect carnival of trust building and it was carried on with complete disregard of the Sherman law's prohibitions. Many of our readers will recall how rapid were the movements in those halcyon days of high finance. Great combinations were rolled up like snowballs. Every morning brought news of the purchase and consolidation of independent factories to form a trust and a few days afterward would come news concerning consolidation of the merged concerns with competitors to form a bigger trust.

There was no pretense, either, in those days that the intention of the combinations was not the limitation of competition. One of the main grounds on which the public was asked to buy stocks in the trusts was the claim that the elimination of competition would make possible much larger profits. In many lines of industry the combinations actually controlled the great bulk of the productive capacity. The promoters of a big trust, in fact, generally aimed to include all the mills in the industry which could be profitably operated. The only exceptions made by the trust organizers were concerns so limited in output or handicapped in location or otherwise that their competition would be no serious factor, or, on the other hand, an occasional concern whose owners demanded a price for their plant too big even for the swollen capitalization of high finance to concede. It needs only common sense for any one to understand that such combinations as resulted in the formation of the Federal Steel Co., the National Tube Co., the American Steel & Wire Co., the American Sheet & Tin Plate Co. and many others which might be named were a direct infraction of the Sherman law.

If the economic advantages of consolidation had been as great as the trust promoters claimed, the new combinations would have attained a position of monopoly in the various industries which would have resulted long ere this in some serious outburst of public indignation which might not have stopped short of revolution. What has happened, however, in most of the trust-controlled industries is that a large number of independent concerns have grown up and have found it possible to do a very profitable business in competition with their huge rivals.

It should be freely recognized that this would probably not have been the case in the steel industry had the Steel Corporation pursued such methods towards its competitors as were followed by the Standard Oil Co. and the American Tobacco Co. It has been, and is, argued that because of this fact the Steel Corporation and its component parts do not infringe the Sherman law. It may indeed be that when the case is finally passed upon by the courts, the question whether the Steel Corporation has made commendable use of its great power may prove of great weight in the final decision. It may be argued also that if the Steel Corporation has at the present time strong competition in all its lines of production, it is not now infringing the law, even though the original formation of the Corporation and its component parts was an infringement. It is probable that the defense will be based upon these grounds, for it cannot be seriously contended that the promoters who held high carnival in constructing the trust and its predecessor trusts a dozen years ago were not proceeding in direct infringement of the Sherman law.

One of the first comments which must occur to almost every one looking at the matter from an unprejudiced point of view is that the present suit ought to have been brought ten years ago. The present case, it must be remembered, is not a criminal prosecution but a civil suit. What has happened is that a great number of manufacturing concerns, mines, railways, ships, etc., have been bought, consolidated and then sold to the general public through the stock market at many times their cost. By this process a few capitalists have rolled up fortunes which are the marvel of modern times, and hundreds of thousands of innocent holders of stock have become real owners of the so-called trusts.

It is beyond the power of any law or any court at the present day to undo all the buying and selling and all the transfers of properties and of money which have taken place in the past ten years. Whether the fortunes which the trust organizers acquired ten years ago were acquired legally or illegally, they cannot now be taken away from these men or from their heirs.

Again, the holders of stocks and bonds in the various consolidations cannot in equity be deprived of their property when they have acquired it innocently and legally. They cannot be deprived, that is, of the title to their property, but the value of their holdings will depend very much upon future events. If, for instance, the common stock in a concern is earning dividends through the power of the concern to fix exorbitant prices for its product by virtue of its monopolistic power, then sooner or later it must be expected that the value of this common stock will be wiped out.

In the case of not a few of the trusts this has actually happened. The growth of independent concerns, often better managed and with better plant than the trust, has destroyed the monopolistic power of the once potent combination. If any combination still retains a monopoly control over the market, then its infraction of the Anti-trust Law is no longer doubtful. The public's right to be served with goods at prices fixed through free competition will doubtless be adjudged superior to the property rights of any stockholder.

It is vastly easier to see wherein the Steel Corporation has infringed the Sherman law than it is to say what remedial measures can be fair to the public, the owners of Steel stocks and bonds, and to Steel employees and competitors, in case the Government's suit just filed is successful.

It is said that the chief figure in the financial world when asked how it would be possible to dissolve one of the great combinations which he had been instrumental in organizing replied, "How can you unscramble an egg?"

It might be even easier to restore the egg to its original form and proportions than it would be to restore the steel industry, for example, to the identical position in which it stood twelve or thirteen years ago. Such a restoration will be admitted by all to be impossible. Many of the concerns which were purchased have been wiped out of existence; many of the plants have been dismantled. Many entirely new plants have been built. A complicated network of stocks, bonds, notes, contracts, and other obligations have been created producing a maze of complications which would well nigh defy the power of any attorney or any court to disentangle.

It may be confidently predicted that whatever the outcome of the litigation now started, the properties of the Steel Corporation cannot be and will not be divided into the multitude of small independent concerns that existed twenty years ago. What could be done, although even this would be attended with grave difficulties, would be to abolish the holding company—a lawyer's scheme which has been looked upon from the beginning with great opposition by many of the best business men and lawyers. It might be possible to reconstruct as independent concerns such units as the Carnegie Steel Co., the Illinois Steel Co., the American Steel & Wire Co., the American Bridge Co., the Tennessee Coal & Iron Co., and so on. Such division would still leave the independent units of no great magni-

ties, probably, as can be profitably handled under one management.

The growth of independent competition in the steel industry has been so great in the past ten years that some such dissolution, if decreed by the court, might satisfy all demands on the part of the public. Even such a division would involve problems of grave difficulty in the equitable treatment of the different classes of the stock and bond holders. It is worth noting that the Government's suit asks for such decrees with reference to the stock issued by the Corporation and its components "as shall be in accordance with equity and good conscience."

LETTERS TO THE EDITOR.

State Bureaus of Public Works.

Sir: I read with much interest the editorial in your issue of Oct. 12, entitled, "State Supervision of Engineering Work." You have struck a live subject and I sincerely hope you will keep after it. Every state should have a Public Works Bureau. "Bureau" is correct. I have heretofore called it "Commission," but we shall have not so very long hence a State Executive Commission to replace the governor, so let us call the subordinate branches "Bureaus."

The Public Works Bureau should consist of perhaps three men, all to be civil engineers, with terms of six years, one to be appointed every two years by the Governor. This bureau should have charge of all state engineering work, and it should be established by the constitution, and not be subject to abolition by simple legislative enactment at the behest of some disreputable or any other kind of political boss.

The fate of highway work in the State of New York proves the inadvisability of trying to give stability to a department by simple legislative enactment. One political party when in power established a bipartisan method of conducting the state highway work, and the work was so organized and conducted. Another political party got control two years later and absolutely, without any reason except to further the ends of self-seeking politicians, abolished the bipartisan organization and set going a strictly partisan one.

Such prostitution of the public service should be stopped and I doubt if it can be done effectively without a constitutional amendment establishing something in the nature of a Public Works Bureau as outlined above.

It cannot be done without the combined effort of all who are anxious to eradicate inefficiency and instability in public work.

Very respectfully,

F. Warren Allen,

Supt. Public Works, San Juan, Porto Rico.

San Juan, Porto Rico, Oct. 23, 1911.

Why Not Individual or Sub-District Sewage Treatment Works for the Sewage of the Lower Passaic Valley?

Sir: The letter by "Jerseyman" in Engineering News of Oct. 19, 1911, relative to the Passaic Valley sewage disposal is very interesting and very much to the point.

The natural channel for the discharge of water from the Passaic Valley is the Passaic River, and it seems foolish to construct a trunk sewer to parallel this natural water course for so many miles. The obvious plan would seem to be to build a disposal works for each municipality, or each group of municipalities that form a natural drainage area.

The greatest objection to such a plan is not that of cost of construction or cost of maintenance but the difficulty of overcoming the opposition to the location of disposal works at suitable points. Nature has determined these locations within certain reasonable limits but those who have interests at or near these locations do not want the disposal works placed there. Even when shown that by modern methods a disposal works need not be unsightly or a source of objectionable odor the great majority of people refuse to be convinced. The objection is largely sentimental, like the objection to a cemetery.

The proposition to purify sewage locally is especially well adapted to the community formed by Montclair, Orange, East Orange, Glen Ridge and Bloomfield, because they use a system of sanitary sewers separate from the storm-water sewers.

Montclair, Orange and East Orange have recognized this and have failed to enter into a contract with the Passaic Valley Sewerage Commission; they expected Glen Ridge and Bloomfield to join them. The site proposed for the disposal works is located partly in Belleville and partly in Bloomfield, and these two municipalities are doing all in their power to prevent this plan from being carried out. No one can predict the outcome.

The sewers of Paterson and a large part of Newark carry both sanitary sewage and storm water. If disposal works for these cities were designed to purify the dry-weather sewage flow and a portion of the storm-water flow the excess might be allowed to overflow into the river direct without creating a nuisance. In time separate sanitary sewers could be introduced and the present combined sewers left for storm water only.

Another consideration, which must be admitted with shame, is that our American local governments are not as efficient as those of England and Germany, and what would be a success there might be a failure here. Personally, I believe the construction of the Passaic trunk sewer to be a great mistake, but it looks very much as though it would be built as planned.

James E. Brooks, M. E.

Glen Ridge, New Jersey, Oct. 23, 1911.

The Impossibility of Providing Spillway Capacity to Pass the Greatest Recorded Floods.

Sir: I wish to add a word of emphasis to your editorial in last week's issue relative to the proportioning of reservoir spillways. While it is true that many spillways are built without proper study of the conditions which may produce floods, it is also true that in most localities a flood may some time come which will exceed the capacity of spillways built with the best engineering foresight.

By way of illustration, it may be well to refer to some recent flood records. Some of the readers of Engineering News may recall the great floods of May, 1901, in the Southern States. A paper on these floods by Mr. E. W. Myers, Assoc. M. Am. Soc. C. E., was printed in Engineering News, Aug. 7, 1902. As there recorded, the Catawba River, in North Carolina, which has a drainage area of 2,987 sq. mi. above Rock Hill, S. C., had a maximum flood flow of over 50 cu. ft. per sec. per sq. mi. of drainage area. At a higher point on the same stream, Catawba Station, where the tributary drainage area is 1,535 sq. mi., the maximum flood flow was 62 cu. ft. per sec. per sq. mile.

Vastly larger flows were recorded on small watersheds. Cane Creek, N. C., a small stream draining an area of 22 sq. mi. above the hamlet of Bakersville, sent down a flood estimated at 1,341 cu. ft. per sec. per sq. mile. of drainage area.

In the following month, June, 1901, equally severe floods, causing large loss of life, occurred in West Virginia. The small stream known as Elk Horn Creek, which drains an area of 44 sq. mi. above Keystone, W. Va., recorded a maximum flood flow of 1,363 cu. ft. per sec. per mi., and an average flood flow for 14 hours of 278 cu. ft. per sec. per sq. mi. of tributary area.

These and all other records of flood flow, of which the writer is aware, were far surpassed, however, by the flood which wrought destruction in the city of Monterrey, Mexico, on Aug. 27, 1909. As reported by Mr. Conway in Engineering News of Sept. 23, 1909, the watershed of 544 sq. mi. above Monterrey sent down a flood upon the city amounting to 590 cu. ft. per sec. per sq. mi. at its maximum height.

It may be possible to design dams on municipal water-supplies having small tributary area, so as to pass even the maximum possible flood, and the same thing is true in lesser degree concerning dams built to store water for irrigation. But where dams are built for water power on large rivers, the engineer cannot expect to provide spillway capacity sufficient to pass all possible floods without more or less resulting damage. It would be well, however, if the profession were favored with some authoritative discussion defining what is correct practice as to provision for flood flow under such circumstances.

Very truly yours,

"Hydraulic Constructor."

Pittsburgh, Penna., Oct. 28, 1911.

More Pseudo-Science on the Austin Dam Failure.

Sir: All engineers are familiar with the popular notion that hydrostatic pressure on a dam depends on the area of the water back of it rather than on the head. Many readers will remember the apt illustration used by a sometime Chief Engineer, in order to quiet certain Congressmen who were fearful of the safety of the Gatun dam on account of the great amount of water in the lake. The Chief recommended to their consideration the dikes of Holland, which withstand the **entire Atlantic Ocean.**

It has remained for F. G. Myhlertz, of Philadelphia, to offer something original in the field of hydraulic engineering. In a three-quarter column letter in the Philadelphia "Public Ledger" of Oct. 22, he confutes published statements as to the cause of the Austin dam failure, as follows:

> Admitting the condition stated to be correct [hydrostatic pressure under dam] there was, nevertheless, no additional water pressure upon the dam * * *. As a matter of fact the pressure would be less than under normal conditions, for the reason that the leakage acted somewhat as a safety valve in so far as pressure against the dam is concerned. If the dam breast had been properly and safely designed and erected independently of its base or footings the water would have flown out under the dam breast until the dam breast sank into the water in the sub-stream as a stone sinks, whereupon the water would have flown over as well as under the dam breast and the total pressure upon the dam breast would have been materially reduced * * *. It must be plain to anyone, upon mature consideration, that the actual pressure upon the dam breast was reduced by the leakage underneath upon the same principle that a safety valve reduces and limits the steam pressure upon a boiler * * *."

According to this deduction, "upon mature consideration," it would seem that a few leaks are good for a dam. If leaks are not convenient, then in order to insure the stability of the dam it is only necessary to set a few safety valves near the base. If these valves were large enough and were set to open under a few feet of head they would no doubt be very effective in preventing accidents! Yours truly,

W. G. McNees.

Room 401, Penna. Bldg., Wilmington, Del., Oct. 28, 1911.

Why Should Not an Engineer Consult a Well Digger in Laying a Dam Foundation?

Sir: I have read Mr. Riegel's answer to the question, "Should an Engineer Consult a Geologist in Laying a Dam Foundation?" Yes; I have read it at least four times without understanding all of it. I have no authority to speak for "the engineering profession as a whole"; but as an individual I resent the accusations heaped upon us in such phrases as "the overweening pretense," "vaunted expertness," "tank of vanity," and the implication that it is not "beneath" our "standing" "to have skyhooks, or their equivalent," "suggested" "to the responsible head of enterprises" as the proper means of preventing failures to engineering structures.

I do not believe it is a fact that engineers as a class are unwilling "to consult real sources of information." On the contrary, I believe that engineers consult more "sources of information" than any other professional man ever thought of doing before he writes his prescription.

The absolute necessity for thorough investigation is drilled into us through our entire college course. Though I have almost forgotten everything I ever learned in college. I do not believe I will ever forget the exhortations to consult the latest authorities, to supplement our standard text-books with the up-to-date engineering periodicals, the current professional bulletins, the latest catalogs, the most recent editions of specifications.

In my limited experience, I have universally found this system most conscientiously pursued. My superiors have not only allowed but they have encouraged the broadest latitude in consulting "sources of information"; I have been asked to read this and examine that, to compare these and look into those, and then to make some figures on it; in a word, to take nothing for granted without scrupulous investigation.

But thorough investigations and careful calculations are seldom complete without the use of "level and transit and tape line and logarithms," and other tools at our command and within the limits of the appropriation available.

Alas! the appropriation available! for it is too often true that owners "buy just as little engineering and buy it just as cheaply as they possibly can," to quote from your recent editorial on "The Austin Dam Failure and Its Lessons."

Although much of the information and knowledge of the geologists is second hand, I do not believe that "many engineers" spurn it. They take it for what it is worth and perhaps often more than it is worth; but they prefer getting it at first hand—from the underground worker, the

mine owner, the tunnel driver, the basement excavator, the well digger.

Information obtained from a tube well driller has formed the basis of authoritative expert reports on extensive geological formations. Why consult a geologist when we can get the knowledge he possesses in his "tank of vanity" by application to the well digger? Let us be fair and square; let us give the well digger a chance when we wish "to consult real sources of information."

John Berg.

860 Hunt's Point Ave., N. Y. City, Oct. 24, 1911.

Experience with Percolation Under Dams.

Sir: The thoughts suggested by Mr. Freeman in your issue of Oct. 19, relative to the failure of the dam at Austin, Pa., are worthy of most careful consideration. The writer believes that too little attention is usually given to the upward pressure that may be caused by the water which has been forced below the base of a dam under the static pressure of the impounded water and this element of danger is by no means confined to masonry dams but applies as well to earth dams and in an especial degree when this type of dam rests upon a rock foundation of a porous nature.

In Engineering News of Oct. 12, Mr. C. W. Comstock, State Engineer of Colorado, refers to the "Jumbo Dam," located near Sedgwick, Colo., which failed in March, 1910. The writer was engaged to investigate and report upon the probable cause of this failure and later prepared plans and supervised the reconstruction.

This dam is one of six earth dams which impound water in a basin, known as the Julesburg Reservoir. It was originally built upon a stratified formation of sandstone, the strata of which were sufficiently separated to readily admit water between them. This rock formation also contained pockets filled with sand, much of which had been gradually washed out, leaving the pockets and horizontal joints between the several strata filled with water under pressure, due to the reservoir head. This upward pressure probably existed at least 30 ft. below the top of the original rock surface or base of the dam. The dam failed first at the point of least resistance, which was at the lower toe; at which point the rock was lifted in great blocks, some of which measured over 30 cu. yds. in bulk, and were swept down the draw by the force of the escaping flood, which immediately followed the rupture of the rock-bed.

Mr. Freeman correctly states that "we must always expect percolation." He refers to one dam which has come under his personal observation, which is free from seepage. The writer knows of the dam referred to and he has always attributed its remarkable freedom from leakage to the arch effect, the pressure of the impounded water tending to insure tightness; this in addition to the excellence of the work.

Surely this suggestion of Mr. Freeman—that of preventing an accumulation of water below or within the dam section, with its consequent upward pressure—should as far as possible be followed and such percolation of water prevented by suitable "cut-offs" of ample proportions.

The writer has in mind another dam, upon which he has devoted considerable time and attention, although not connected with the original design and construction. This dam, it is believed, would undoubtedly fail were it not for the natural drainage which occurs many feet below its base; so low, in fact, that seepage is in evidence in large amount fully 1½ miles below the structure. This drainage, which nature has provided, emphasizes the wisdom of the plan so often suggested in connection with earth-dam construction, that of providing ample drainage facilities in the lower slope to readily dispose of any percolating water, the amount of which should be minimized as much as possible, as above indicated.

Geo. T. Prince.

Symes Building, Denver, Colo., Oct. 27, 1911.

Allowing for Uplift and Making Geological Studies for Dams.

Sir: In Engineering News of the 19th inst., Mr. John R. Freeman mentions that "many or most of our standard books * * * have little to say about the danger of uplift pressure within or beneath a high masonry dam and the great importance of providing against it."

Although "The Civil Engineer's Pocket-Book" does indeed have little to say on this subject (its function forbids the use of unnecessary words), it is not silent respecting it. On page 436, under "Practical Considerations," we read:

> The assumption of ideal conditions is particularly dangerous in the case of masonry dams. Thus, any compression of the material at the downstream face may open seams on the upstream face; and water, entering these seams, will exert a wedge-like action, shifting the resistance line further downstream, thus still further increasing the tendency to crushing on the downstream face and to opening on the upstream face. Again, if any relatively smooth joints have been left, the water, thus penetrating into or under the dam, increases the tendency to slide, not only by diminishing the effective weight of the upper portions, but also by acting as a lubricant upon the seam where it penetrates.

At Austin, Pa., the "relatively smooth joint" was evidently the one left by nature between the upper solid rock stratum, upon which the dam rested, and a solid stratum below, a lubricated stratum of loose shale having been left in this joint, so that the upper solid stratum, carrying the dam with it, slid over the lower one.

But it also seems that there was some tipping, accompanied by crushing of the (downstream) toe, and probably by opening at the (upstream) heel, as well as sliding; for you say that, in January, 1910, "a section of the dam—slid out at the bottom 18 ins. and at the top about 31 ins.," or 13 ins. farther at top than at bottom, showing that at least this portion of the dam, instead of preserving its verticality as it slid forward, also *tipped* forward. This is confirmed by one of your photographs, where you call attention to the "extensive shattering at toe of undisturbed part of dam."

Such forward tipping indicates very heavy unit pressures upon the material at the toe of the dam; and these pressures, by incipient spalling at the toe, narrowed the effective base, thus not only increasing the mean unit-pressure upon the base, but also probably reducing the distance between the toe and the resultant of the pressures, thus further increasing the unit-pressure at the toe, and diminishing the resisting leverage of the weight of the dam, while the destructive leverage of the water pressure probably remained undiminished.

All this action, of course, increased the spalling at the toe, and so on in a vicious circle; at the same time probably lifting the (upstream) heel of the dam, thus greatly facilitating the penetration of water, from the pool, under the dam.

While it does appear that, in this instance, insufficient attention was given to the geological conditions, your correspondent, Mr. John I. Riegel, is unjustly severe in attributing to engineers in general an "overweening pretense" which forbids their consulting "real sources of information."

It is common practice to seek out and consult "the oldest inhabitant," as to records of maximum floods and other local conditions; and I venture to say that not one engineer in ten, in designing an important dam, would neglect to consult every possible source of information, however humble, respecting the geology of the neighborhood.

John C. Trautwine, Jr.

257 South Fourth St., Philadelphia, Pa., Oct. 26, 1911.

Canadian Trans-Continental Ry.—The National Trans-Continental Ry., in Canada, is making rapid progress. The total grading done to the close of March, this year, was 1,388 miles. The track laid at the same date was over 1,064 miles of the main line and 199 miles of sidings. The total contracts let for steel superstructures, bridges and viaducts to the close of March, this year, amounted to 49,084 tons. The completed portion of the system has thus far been worked by the Grand Trunk Pacific Ry. Co.—"Engineering."

Fenders for the Approach Walls of the Panama Canal Locks.

The approach to the locks of the Panama Canal is formed by an extension of the center wall to a distance varying from 1,445 to 1,700 ft. beyond the first lock gates, and by wing walls which make an angle of about 30° with the outside walls and extend 300 to 400 ft. beyond them. To take the shock of ships bumping against these walls as they are hauled into the locks by the electric towing locomotives the walls will be fitted with wooden stringers 12 × 16 ins. in section, hung longitudinally along the face of the wall by chains, and bearing every 5 ft. against castings supported by a nest of four helical springs.

The cups (Fig. 1) in which the springs are nested are anchored into the concrete walls by a 1-in. flange on the top and bottom of the back face. These castings are 17¾ ins. long, 14¼ ins. wide, and 11½ ins. deep, and weigh about 216 lbs. each. The movable buffer casting or plunger (Fig. 2) is 16 ins. long, 12⅝ ins. wide and 10⅝ ins. deep, giving it 1/16-in. clearance on the four sides of the cup in which it slides. The sliding part of the buffer is 13 ins. square and has lugs 1 × 2 ins. on each side which fit into corresponding grooves in the cups, to keep the plungers from jamming.

The springs will be made of carbon or chrome spring steel. They will be 12¼ ins. long when free and 9¼ ins. long when compressed as far as the plunger will slide. The inside diameter of the coil is $3^1/_{16}$ ins., and the bar of which the coil is made is 1 in. in diameter. The springs are arranged in the form of a square 5¾ ins. between centers. Each spring must be capable of being compressed not less than 3 ins. and not more than 3½ ins. under a load of 7,500 lbs.

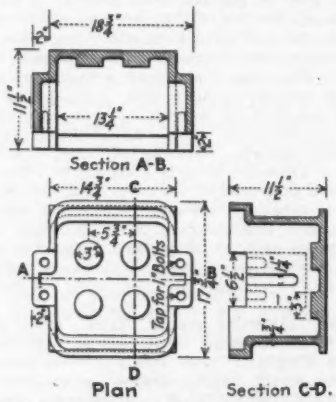

Fig. 1. Buffer Casting; Wall Cup.

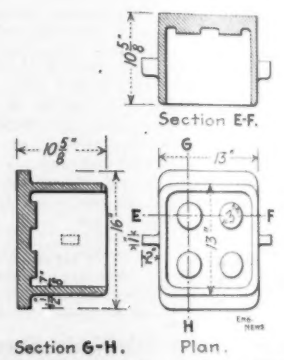

Fig. 2. Buffer Casting; Sliding Plunger.

The stringers will hang by three links from eyes on the ends of steel bolts, 1½ ins. in diameter and embedded in the concrete masonry 2 ft. 5½ ins. These anchor bolts are provided with bearing blocks (B, Fig. 3), 6¾ × $5^{29}/_{32}$ ins. and 3⅜ ins. and wide grooved to carry the bent rod, which are embedded in the concrete. The hangers are located at intervals of 15 ft. along the walls.

Each hanger bolt will splice together two stringers, so that each row of fenders will be a continuous line of stringers. The shortest of these will be on the upper approach wall at Gatun, 970 ft., and the longest will be on the lower approach walls at Gatun, 1,202 ft. There will be a double line of buffers on each wall (except the upper walls at the Miraflores and Pedro Miguel locks) 7 ft. 6 ins. apart center to center, the upper buffer being placed 2 ft. 6 ins. below the top of the wall and the second one 10 ft. below the top, as shown in Fig. 4.

In all the locks there will be 48 rows of stringers requiring 31,659 ft. of timber. These will require 6,394 buffer castings of each kind, weighing in all 2,659,904 lbs. These castings and the 2,168 bearing blocks will be made at the Government foundry at Gorgona, C. Z. In addition to these materials there are required several thousand pounds of timber bolts, anchor rods and washers, making a total of over 137,000 lbs. exclusive of the springs.

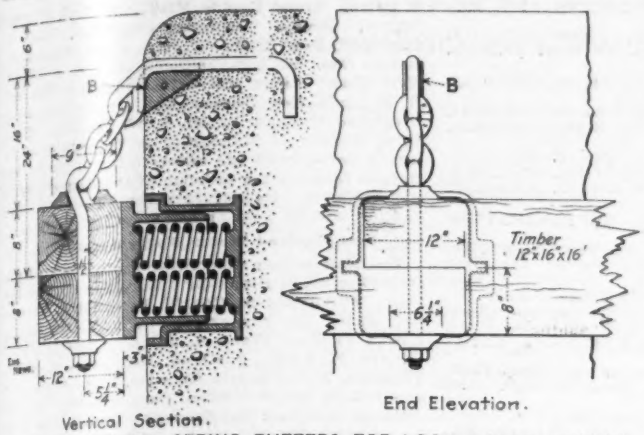

FIG. 3. HELICAL SPRING BUFFERS FOR LOCK WALLS, PANAMA CANAL.

Notes From Engineering Schools.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—A course of instruction in knots and splices has been instituted at the suggestion of Major E. T. Cole, U. S. A., Instructor in Military Science. The course is optional, and will consist of a half-hour period once or twice a week for acquiring, with practice, the simple principles of knots and rigging. Various knots, bonds and hitches will be considered, together with the appropriate use of each and the precautions for avoiding unsafe knots. This course is based on that taught at the Army Service School, the value of which has been demonstrated for all branches of the military service.

Boiler, Elevator and Flywheel accidents in the United States and Canada during the month of August, 1911, caused the death of 29 persons, according to lists compiled by the Fidelity & Casualty Co., of New York, as compared with 33 in the previous month. The decrease was due chiefly to the fewer fatalities in boiler accidents. Although 22 boiler explosions are listed for the month, only six persons were killed by them, as compared with eleven killed in July. The most serious boiler explosion, from the standpoint of loss of life (two men killed) occurred at Eaton, Ind., Aug. 14, and was noted briefly in our issue of Aug. 24. The number of elevator accidents in August was 100, the highest for a period of eleven months, but the number of persons killed, 22, was but little above the average. Of those killed in elevator accidents, eleven fell down shafts, nine were struck or crushed by elevator weights or cars and two were killed by the fall of cars. Flywheel explosions numbered seven, including four grinding-wheel explosions, and killed only one man.

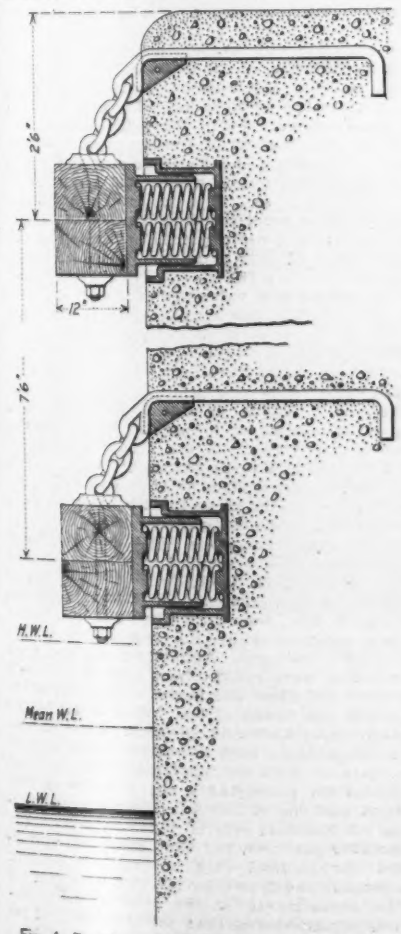

Fig. 4. Position of Stringers on Lock Walls.

A Butting Collision took place on the Union Pacific Ry., at Rock River, eight miles west of Cheyenne, Wyo., Oct. 28, between the Atlantic express, east bound, and a freight train standing on a siding. Four persons were killed and 23 others injured. The accident is ascribed to the failure of a brakeman to close the switch leading to the siding. Reports state that the express train was running at 50 mi. per hr. Both locomotives and a number of cars were wrecked.

By the Capsizing of a Monoplane Glider with which experiments were being conducted, Prof. J. J. Montgomery, of Santa Clara College, was killed on Oct. 31, near San Jose, Cal. Prof. Montgomery was one of the earliest experimenters in aviation in this country and in 1905 attracted attention with self-equilibrating gliders which were released from balloons and carried hired aeronauts. One flight with a damaged machine resulted in the death of the rider.

Grit Chambers, Imhoff Tanks, Sprinkling Filters, secondary Imhoff tanks and final disinfection have been recommended for the treatment of the sewage of Orange, Montclair and East Orange, N. J., in a report by Mr. James H. Fuertes, M. Am. Soc. C. E., New York City. The plant would be located partly in Bloomfield and partly in Belleville, on a small stream called the Yantecaw River, a few miles above its junction with the Passaic River. Works sufficient until 1940 are estimated to cost $1,246,000 for construction and $108,000 for annual charges, against $1,916,409 and $153,567, respectively, for entering the Passaic trunk sewer. Mr. Fuertes advises the formation of a joint administrative commission to build and operate the disposal works and the connection between the works and the present local sewerage system.

The Cross-Country Flight of C. P. Rodgers, who started from New York on Sept. 17 and whose early accidents were subsequently noted in Engineernig News, reached Willcox, Arizona, on Oct. 31. This makes the total length of trip 2,603 miles, or 1,338 miles more than the previous record made by H. N. Atwood, between St. Louis and New York. There still remain 1,078 miles to San Francisco. After reaching Chicago on Oct. 8, Rodgers turned southwest as far as San Antonio, Texas, evidently to avoid the Rocky Mountains. The following is an abbreviated schedule of this trip: Chicago, 1,199 miles, Oct. 8; Kansas City, Mo., 1,482 miles, Oct. 11; San Antonio, Texas, 1,789 miles, Oct. 22; Sanderson, Tex., 2,069 miles, Oct. 26; Sierra Blanca, 2,291 miles, Oct. 28; El Paso, 2,381 miles, Oct. 29; Willcox, Ariz., 2,603 miles, Oct. 31.

A Record for Time by Rail between Seattle, Wash., and New York City, was established on Oct. 16, when a trainload of silk valued at $2,000,000 arrived at New York from China, via Seattle. The total distance of 3,178 miles was covered in 82¼ hrs., which is a little better than 15 hrs. faster than the best previous record of 97⅝ hrs. for any run between the two coasts. This time is about 8½ hrs. better than a passenger can make by connections with the fastest trains between New York and San Francisco. The train left Seattle early Friday morning, Oct. 13, and came over the Great Northern, Chicago, Burlington & Quincy and New York Central lines via St. Paul and Chicago.

The Commission Plan of City Government will be voted on at Cambridge, Mass., on Nov. 7. Mr. Lewis J. Johnson, Professor of Civil Engineering, Harvard University, four other professors in the engineering departments and ten other Harvard professors are members of the Committee of One Hundred which is conducting the charter campaign. Professor Johnson is chairman of the committee. Of the 100 members of the committee 45 have held elective or appointive state offices.

Personals.

Mr. Willis Whited, M. Am. Soc. C. E., Assistant Engineer, Department of Public Works, Pittsburgh, Pa., has been appointed Bridge Engineer of the Pennsylvania State Highway Commission, at a salary of $3,600 per annum.

Mr. P. J. Flynn, formerly Freight Traffic Manager of the Delaware, Lackawanna & Western R. R., at New York City, has been elected Vice-President in charge of traffic of the same road, succeeding Mr. B. D. Caldwell, resigned.

Mr. Martin J. Caples, formerly Vice-President and General Manager of the Carolina, Clinchfield & Ohio Ry., has been elected Fourth Vice-President in charge operating and construction departments of the Chesapeake & Ohio Ry.

Mr. J. S. Calhoun, formerly Supt. of Construction for the Newport Contracting and Engineering Co., Newport News, Va., is now with the Charleston Engineering and Contracting Co., Charleston, S. C.

Prof. Emory R. Johnson, of the University of Pennsylvania, has been appointed by President Taft, Special Commissioner to investigate the prospective traffic through the Panama Canal, for the purpose of fixing upon an equitable tonnage rate.

Mr. D. Sterritt Pindell, formerly a consulting engineer of Sault Ste. Marie, Ont., and Chicago, Ill., has joined the staff of the engineering firm of C. G. Young, Assoc. M. Soc. C. E., 60 Wall St., New York City, and will make a specialty of engineering examinations and reports.

The Union Pacific Ry. announces the following promotions: Mr. J. A. Monroe, from Freight Traffic Manager to Vice-President in charge of traffic; Mr. W. B. Scott, from Assistant Director of Maintenance and Operation to Vice-President and General Manager; Mr. T. M. Orr, from Assistant General Manager to Assistant to the President.

Messrs. M. A. Beck, R. G. Butler, Edward Cornillie, John J. McSweeney, F. J. Weber, W. G. Bruce, A. L. Worden, Robert Clarke and W. P. Bishop have been appointed a Harbor Commission for Milwaukee, Wis., by Mayor Seidel, to investigate the feasibility of the plans for harbor improvements submitted by Mr. Isham Randolph, M. Am. Soc. C. E., of Chicago.

Prof. Francis W. Chandler, Hon. M. Am. Inst. Arch., head of the architectural department of the Massachusetts Institute of Technology, has retired after many years of service. He has been Professor of Architecture at the Institute since 1888. He has been a member of the Board of Art Commissioners of the City of Boston since 1898, and is distinguished as an author and editor.

Mr. Wm. B. Fuller, M. Am. Soc. C. E., a member of the firm of Johnson & Fuller, Consulting Engineers, New York City, has been appointed Chief Engineer of the Mexican Northern Power Co., Ltd., with headquarters at Santa Rosalie, Chihuahua, Mexico. Mr. Fuller will have supervision of the construction of two large masonry dams, a large power house and 50 miles of transmission line.

Mr. Dewitt V. Moore, formerly of the Moore-Mansfield Construction Co., and the Mansfield Engineering Co., of Indianapolis, Ind., has disposed of his interests in the above mentioned firms and has become associated with the W. C. Halstead Co., Contractors, of Indianapolis, as an engineer-contractor, with offices in the Indiana Pythian Building.

Prof. C. L. Parsons, of New Hampshire State College, Durham, N. H., Secretary of the American Chemical Society has been appointed Chief Chemist of the Mineral Division, U. S. Bureau of Mines, in charge of mineral technology. His work will start with investigations into the conservation, development and utilization of mineral products of the country. His headquarters will be in Washington, D. C.

Mr. Prévost Hubbard, formerly Chief Chemist of the U. S. Office of Public Roads, Washington, D. C., has become associated with the Institute of Industrial Research, of Washington, as Chief of

the Division of Roads and Pavements. Mr. Hubbard is the author of a number of Government publications having to do with the examination and use of bituminous road materials, and of the book "Dust Preventives and Road Binders." Mr. Hubbard will also devote some time to work as instructor in the chemistry of road making materials in the newly established highway engineering courses at Columbia University.

Prof. F. G. Cottrell has resigned as Assistant Professor of Physical Chemistry at the University of California, to become Physical Chemist of the U. S. Bureau of Mines. His headquarters will be at the Astor House and Appraiser's Bldg., San Francisco, and his work will be related to the extension of the Bureau's work from coal to metal mining. It is expected that a start will be made with a general investigation of the problems of smelter fumes. Prof. Cottrell is the inventor of a successful process for the electrical precipitation of fumes, as described in Engineering News, Oct. 26, 1911.

Obituary.

T. J. Conners, Superintendent of the Cincinnati Division of the Chesapeake & Ohio Ry., died on Oct. 21, at Covington, Ky.

Robert Evans Young, Chief Dominion Geographer and Superintendent of Railway Lands, Department of the Interior, of Canada, died in Ottawa, Ont., on Oct. 23, from heart disease.

Charles J. L. Lantry, a prominent railway contractor, died in Asheville, N. C., on Oct. 27, from pneumonia. He was a member of the contracting firm of Lantry & Sons, Denver, Colo., who graded the roadbed of the famous Pikes Peak Ry. in 1889-90.

Maj. John P. Waring, a brother of the late Col. Geo. E. Waring, and an inventor of mechanical appliances, chiefly those connected with the manufacture of silk goods, died in Flushing, N. Y., on Oct. 30 at the age of 77 years. During the Civil War Maj. Waring served in the cavalry, engineer and ordnance departments. For many years following the war he was connected with the Cheney Bros. silk works at South Manchester, Conn.

Rear-Admiral James H. Sands, U. S. N., retired, died at his home in Washington, D. C., on Oct. 27, from acute indigestion. He was born in Washington in 1845, the son of Rear-Admiral B. F. Sands, a distinguished officer of the United States Navy, who died in 1884. Rear-Admiral Sands graduated from U. S. Naval Academy at Annapolis in 1863, and immediately saw active service in the Civil War then in progress. Two of his more important assignments in after life were those of commandant of the League Island Navy Yard and Superintendent of the Naval Academy

Robert Creuzbaur, an engineer in the early days of Texas, died in Brooklyn, N. Y., on Oct. 23, at the age of 88 years. He was born in Carlsruhe, Germany, and appears to have inherited an adventurous disposition from his father, who was a captain of artillery under Napoleon in his disastrous Russian campaign. His mother was an Austrian countess. The family came to this country a number of years before the Civil War and settled in St. Louis, Mo. From here young Creuzbaur emigrated to Texas and was for some time engaged in surveying and engineering work. At the outbreak of the Civil War he joined the Confederate Army and rose to the rank of Major in the Engineer Corps, and while stationed in Richmond designed and built a submarine torpedo boat. Following the war Maj. Creuzbaur returned to Texas and successfully carried on "dry farming" for a number of years. Later he came North to exploit some of his numerous inventions. He leaves six children, among them Mr. Robert Walter Creuzbaur, M. Am. Soc. C. E., a consulting engineer of New York City, and for many years with the Department of Public Works of Brooklyn, N. Y.

Engineering Societies.

COMING MEETINGS.

NATIONAL MUNICIPAL LEAGUE.
Nov. 13-16. Annual meeting at Richmond, Va. Secy., Clinton R. Woodruff, 705 North American Bldg., Philadelphia, Pa.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Nov. 14-17. Annual convention at Rochester, N. Y. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN RAILWAY ASSOCIATION.
Nov. 15. Semi-annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York City.

NATIONAL FOUNDERS' ASSOCIATION.
Nov. 15-16. Annual convention at New York City. Secy., F. W. Hutchings, 915 Hammond Bldg., Detroit, Mich.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting at New York City. Acting Secy., D. H. Cox, 29 West 39th St., New York City

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 17-18. Annual meeting at Canton, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

NEW JERSEY SANITARY ASSOCIATION.
Nov. 24-25. Annual meeting at Lakewood, N. J. Secy., J. A. Exton, 75 Beech St., Arlington, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 4. Annual meeting at New York City. Secy., Wm. H. Ross, 154 Nassau St., New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Dec. 4-9. Annual meeting at Havana, Cuba. Secy., Wm. C. Woodward, Washington, D. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual convention at New York City. Secy., Calvin W. Rice, 29 West 39th St., New York City.

NATIONAL IRRIGATION CONGRESS.
Dec. 5-9. Annual session at Chicago, Ill. Secy., Arthur Hooker, 214 Hotel La Salle, Chicago, Ill.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 11-13. Annual meeting at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 12-14. Annual convention at Washington, D. C. Secy., Glenn Brown, the Octagon, Washington, D. C.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 20-22. Annual meeting at Washington, D. C. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at St. Paul, Minn. Secy., J. B. Davidson, Ames, Iowa.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 3. Annual meeting at Washington, D. C. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

Canadian Society of Civil Engineers.

At a meeting of the general section on Thursday, Oct. 26, Mr. A. W. Robinson presented a paper on "The Rectification of the River Nile." Mr. Robinson has made two visits to the upper Nile as a consulting engineer on dredging operations.

American Railway Association.

Committee reports on the following subjects will be presented at the Fall sessions in Chicago, Ill., Nov. 15: Transportation, Maintenance, Relations Between Railroads, Safe Transportation of Explosives and Other Dangerous Articles, and Electrical Working.

American Society of Civil Engineers.

The Nominating Committee has prepared the following list of nominees for the offices to be filled at the annual meeting on Jan. 17: For president, John A. Ockerson, St. Louis, Mo.; for vice-presidens, Charles S. Churchill, Roanoke, Va., and Charles D. Marx, Stanford University, Cal.; for treasurer, Joseph M. Knap, New York City; for directors, Lincoln Bush, New York City; T. Kennard Thomson, New York City; Emil Gerber, Pittsburgh, Pa.; Wm. Cain, Chapel Hill, N. C.; E. C. Lewis, Nashville, Tenn., and W. A. Cattell, San Francisco, Cal.

American Road Builders' Association.

Among the papers to be presented at the eighth annual convention in Rochester, N. Y., Nov. 14-17, are the following: "Higher Administration," John A. Bensel, State Engineer and Surveyor, New York; "Adaptability of Roads and Pavements to Local Conditions," Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York City; "The Maintenance of Roads and Pavements," James S. Owen, Consulting Engineer, Newark, N. J., and "Problems of Construction," Major W. W. Crosby, Chief Engineer of the Maryland State Roads Commission.

American Institute of Electrical Engineers.

A trip of inspection to the Panama Canal Zone is planned for the coming year by the Board of Directors. A circular has been sent out to the members to ascertain whether a sufficient number would be able to make the trip. It is planned to sail from New York between Jan. 20 and 30. The expense for the round trip would be $125 from New York City. The arrangements for the trip are in charge of Mr. S. D. Sprong, Chairman of the Committee on the Proposed Panama Trip, American Institute of Electrical Engineers, 33 West 39th St., New York City.

American Gas Institute.

Officers were elected as follows at the annual convention in St. Louis, Mo., Oct. 18: President, I. C. Copley, Aurora, Ill.; vice-presidents, V. S. Dewey, Grand Rapids, Mich., and E. N. Wrightington, Boston; secretary-treasurer, Geo. G. Ramsdell, New York; directors, C. H. Holman, St. Louis; Geo. McClain, Dubuque, Ia.; A. S. Miller, New York; Rollin Morris, Philadelphia, Pa., and R. E. Slade, New Orleans, La. Among the papers presented was one by Mr. S. W. Stratton, of the U. S. Bureau of Standards, on "Electrolysis," in which he outlined the efforts being made by the Bureau to solve the problem of the destruction of gas piping by electric currents. The next convention will be held at Atlantic City, N. J.

New England Water Works Association.

The Nominating Committee has announced the following nominations for officers for the ensuing year: For president, Geo. W. Batchelder, Worcester, Mass.; for vice-presidents, J. Waldo Smith, New York City; Frank A. McInnes, Boston, Mass.; Millard F. Hicks, Portland, Me.; John H. Cook, Paterson, N. J.; Morris Knowles, Pittsburgh, Pa.; and Robert Spurr Weston, Boston, Mass.; for additional members to Executive Committee, Geo. A. Stacy, Marlboro, Mass.; John J. Kirkpatrick, Holyoke, Mass., and Randolph Bainbridge, Quincy, Mass.; for secretary, Willard Kent, Narragansett Pier, R. I.; for treasurer, Lewis M. Bancroft, Reading, Mass.; for editor, Richard K. Hale, Boston, Mass.

Conference of the Sanitary Officers of the State of New York.

The eleventh annual conference of this body was held in New York City on Oct. 25, 26 and 27, under the auspices of the State Department of Health. There were papers and discussions on stream pollution, the control of communicable diseases, laboratory work and other health-board activities.

The discussion of stream pollution was opened by Mr. Theo. Horton, M. Am. Soc. C. E., Chief Engineer of the New York State Department of Health. The speaker held that the chief present lack of means to control stream pollution in New York State is not so much legislative authority giving the Department jurisdiction as provision of adequate legal means of enforcing the rulings of the Department. More funds to carry on the work are also needed. As to federal control, stream pollution is more largely a local than a federal matter. The people and the courts alike are loath to have the federal government interfere with what are primarily state matters. Co-operation between states, greater uniformity in state pollution laws and federal research work were suggested by Mr. Horton as desirable.

Dr. McCullough, of the Ontario Board of Health, urged that an international commission on the purity of waters is more needed than is the present International Water Ways Commission. Mr. H. W. Clark, Chemist of the Massachusetts State Board of Health, remarked that stream pollution has two phases, public health and financial. As to the latter, he said that the trades wastes of a Massachusetts wool-scouring city of about 100,000 population contain potash, nitrogen and fats to the value of over a million yearly, which are being turned into the river. Eventually, a large percentage of this value will be recovered and the pollution of the river correspondingly decreased. Mr. Clark thought that Massachusetts has accomplished quite as much abatement of stream pollution as would have been effected under more drastic legislation.

Prof. H. N. Ogden, of Ithaca, N. Y., wondered why a discussion of interstate water pollution was being carried on before a conference of officers of city and town boards of health, chiefly interested in small streams within the state. He was not optimistic as to the likelihood of more than district or drainage area control.

"A Clearing House for Health Departments" was to have been presented by Surgeon-General Walter Wyman, U. S. Public-Health and Marine Hospital Service. Instead, Mr. Robert Lynn Cox (1 Madison Ave., New York City) told of a Health Bureau established by the Association of Life Insurance Presidents. Annual reports and other information were sought from state departments of health and from the health authorities of the 840 cities and towns of the United States having populations of 5,000 and upwards. The responses were discouraging both in number and in content. One state of 2,000,000 inhabitants had published no report for years and a city of 72,000 in Connecticut and one of 28,000 in Illinois print no reports. A Missouri city of 11,000 pays its health officer $200 per year, but that munificent sum includes the medical care of smallpox patients. The conclusions drawn by Mr. Cox were that the health departments of the country are inadequately equipped and that the greatest need for a health-board clearing house lies in the field of stimulation of activity.

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